Conflict and Cooperation on Trade and the Environment

by

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To my parents

Contents

List of Figures

List of Tables

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Declaration

An earlier version of Chapter 2 of this thesis appeared as a working paper in the Warwick Economics Research Paper Series (No. 548) and in the *Note di Lavoro*, Fondazione ENI Enrico Mattei (No. 56/2000); it was also presented at the Royal Economic Society 2000 Conference and the Second International Conference of the Association of Public Economic Theory (APET). An earlier version of Chapter 3 was presented at the 1999 International Economics Study Group (IESG) Conference on International Political Economy. The material on Chapter 4 of the thesis—based on joint work with Carlo Perroni—appeared as a working paper in the Warwick Economics Research Paper Series (No. 558) and in the *Note di Lavoro*, Fondazione ENI Enrico Mattei (No. 57/2000); it was presented at the 2000 Workshop on Coalition Formation at the Universitat Autonoma de Barcelona, at the IESG 25th Annual Conference, and at the Euresco Conference on The International Dimension of Environmental Policy.

Summary

In the first part of this thesis, we examine the influence of green and producer lobbies on the determination of the trade and environmental policies adopted by large countries that are linked by trade flows and transboundary pollution. In Chapter 2, we show that the impact of green lobbying on the relative efficiency of unilateral and cooperative environmental policy outcomes depends crucially on the magnitude of the 'pollution leakages' and on the type of trade policy regime. Our analysis suggests that environmental policy coordination might be more beneficial under a free trade regime.

In Chapter 3, we examine the case where both producer and environmental groups are organized. We find that the nature of the relationship between the two lobbies and the relative efficiency of alternative policy outcomes depend on the type of policy regime, whether governments act unilaterally or cooperatively, and the size of the 'pollution leakages' and the emission spillovers.

The second part of the thesis looks at the formation of international trade and environmental agreements. In Chapter 4, we describe a model of multi-dimensional international negotiations, where countries can enter separate agreements with different partners along different policy dimensions. We examine the implications of negotiation *tie-in*—the requirement that agreements must span multiple dimensions of interaction—for the viability of multilateral cooperation, when countries are linked by international trade flows and transboundary pollution. We show that, while in some cases a tie-in rule has either no effect or can make multilateral cooperation more viable, in others it can make an otherwise viable joint multilateral agreement unstable.

In Chapter 5, we examine international trade negotiations when markets are imperfectly competitive and governments use import tariffs and export subsidies to alter the strategic interaction between oligopolistic firms. Using a simple model of intra-industry trade between three ex-ante symmetric countries, we find that partial agreements involving the coordinated use of both tariffs and subsidies might be stumbling blocs against multilateral trade cooperation. We show that the introduction of an international ban on export subsidies might help to sustain global free trade. Chapter 6 contains some concluding remarks.

Chapter 1

Introduction

Two debates have been at the centre of the international agenda since the early 1990's: the interaction between trade and environmental policy and the relationship between regionalism and multilateralism. This thesis seeks to make a contribution to both.

The renewed interest in the linkages between trade and the environment[1] can be explained by two key developments of the last decade: the growing awareness of the global dimension of problems such as ozone depletion, climate change and wildlife conservation, reflected in the increasing number of international environmental agreements (IEAs)[2]; and the rapid dismantling of tariff and non-tariff barriers throughout the world, both at the regional and multilateral level.

Two general concerns surround the debate on trade and the environment. On one side, there is the fear that the economic boost imparted by freer trade can have a negative impact on the environment. This raises a set of questions: is there a direct link between trade liberalization and environmental degradation? If so, how should trade liberalization strategies incorporate this cost? Should trade policy be used to meet environmental objectives? On the other side, the recent

[1]The debate over the relationship between trade and environmental protection is hardly new, having already received attention at the Stockholm UN Conference on Human Development in 1972.

[2]More than one hundred environmental agreements are currently in force, including the Montreal Protocol on Substances that Deplete the Ozone Layer and the Framework Convention on Climate Change. See Newell and Whalley (2000) for a summary of the features of the main IEAs.

revitalization of concern for environmental quality has generated many questions about the impact of environmental regulations on trade patters and gains from trade. There are concerns that higher environmental standards in one country lend competitive advantage to another. It is argued that, if this is the case, some intervention is needed, either a specific trade policy measure, or an international environmental standard. Should the World Trade Organization (WTO) revise its rules to accomodate the specific trade measure suggested? How can the WTO ensure that the environmental objective is not a guise for a trade barrier?

In this thesis, we focus on two specific aspects of the trade and environment nexus. Firstly, we investigate the role of interest groups in the determination of trade and environmental policies (Chapters 2 and 3). Taking into account the influence of citizens groups at the national and supra-national decision-making level can help us to explain, for example, the delays in the ratification of the Kyoto Protocol on greenhouse emissions or the recent breakdown of the Seattle round of GATT/WTO negotiations. Secondly, we study the interactions between trade and environmental issues at the level of international negotiations (Chapter 4).

The second debate to which our analysis is related—the relationship between regionalism and multilateralism—has been stimulated by the recent surge in the number of preferential trade agreements (PTAs).[3] Despite the successful conclusion of the Uruguay Round and the consequent strengthening of the multilateral trade regime, there is still some concern that increased regional integration may result in the fragmentation of the world economy into competing trade blocs. The risk is that "countries that join trading blocs will be more protectionist towards countries outside the blocs than they were before, so that the world as a whole will be hurt more than helped by moves that at first seem to be liberalizing in intent." (Krugman, 1991, p. 9). Chapter 5 of the thesis addresses this concern, examin-

[3] According to Fratzsher (1996), 94% of world trade is conducted within or between the European Union (EU), the North American Free Trade Agreement (NAFTA) and the Association of South East Asian Nations (ASEAN). In the period 1948-1994, GATT contracting parties notified 118 preferential trade agreements relating to trade in goods, of which 38 in the five years ending in 1994. Since the completion of the Uruguay Round, 80 additional PTAs covering trade in goods and services have been notified. See Whalley and Hamilton (1996) and Sampson (1996) for more information about the recent increase in the number of preferential trade agreements.

ing whether PTAs are stepping stones or stumbling blocs towards the attainment of multilateral trade cooperation, when markets are characterized by imperfect competition.

In the remainder of this introductory chapter, we outline the structure of the thesis and provide a brief summary of the two debates it relates to.

1.1 Outline of the Thesis

The thesis is divided in two parts, each containing two main contributions. The first part looks at the impact of interest groups on the political determination of trade and environmental policies, while the second part looks at the formation of international trade and environmental agreements.

1.1.1 The Influence of Green and Producer Lobbies on the Determination of Trade and Environmental Policies

Recent events in the United States have enlightened the extent to which citizen groups condition trade and environmental policies, both at the national and multilateral level. On the trade side, the creation of the North American Free Trade Agreement (NAFTA) initially encountered the resistance of business, labor and environmental groups. By pledging in an environmental side agreement, the White House was able to win the support of at least some environmental groups and obtain the fast track authority to negotiate the trade agreement without a line-by-line veto from Congress. More recently, environmental groups have joined forces with protectionist industries and labor groups to launch a fierce campaign against further trade liberalization, which has caused the breakdown of the new round of GATT/WTO negotiations in Seattle.[4] Industry and green lobbies have been extremely influential also on the environmental side, participating actively in

[4]See *The Economist*, December 11, 1999.

the debates on domestic environmental standards[5] and multilateral emission cuts.[6]

In Chapter 2, we investigate the impact of green lobbying on the determination of unilateral and cooperative policies. We focus our analysis on two large countries that are linked though trade flows and transboundary pollution. In this scenario, unilateral efforts to reduce pollution by one country shift the comparative advantage of producing 'dirty' goods in favor of the other country. This implies an increase in foreign emissions, which the domestic residents dislike as well.

To describe the relationship between environmental groups and policy-makers, we employ the common agency model pioneered by Bernheim and Whinston (1986) and applied to trade policy by Grossman and Helpman (1994, 1995a,b). National green lobbies confront a national or supra-national government with contribution schedules, namely functions describing their political contributions contingent on the chosen economic policies. These can be interpreted, depending on the context, as legal campaign contributions, support demonstrations, or simply as bribes. The timing is that first lobbies simultaneously commit to contribution schedules, and then governments, having observed these schedules, set trade and environmental policies in a unilateral or cooperative manner. The implicit objective of incumbent politicians is to be re-elected. They trade off the political support that comes from heeding interest groups' demands against the alienation of voters that may result from the implementation of socially costly policies.

We show that the existence of 'pollution leakages' reduces the incentives of environmental groups to lobby for higher domestic pollution taxes. If the pollution leakages and the emissions spillovers are large enough, green lobbies could even support domestic tax reductions. The main result of our analysis is that *the impact of green lobbies on the comparative efficiency of unilateral and cooperative*

[5]For example, both producer and green lobbies have demanded compliance of foreign legislation with American environmental standards on incidental catching of dolphins set out in the Marine Mammal Protection Act.

[6]On one hand, green lobbies have exercised "considerable influence on the negotiations" at the Kyoto Conference in favor of multilateral reductions in greenhouse emissions (*Financial Times*, December 11, 1997). On the other hand, a broad coalition of large corporations and unions has organized "one of the most intensive campaigns ever mounted on a single political issue, seeking to convince that American curbs on greenhouse gas are unfair and damaging to the economy" (*Financial Times*, September 10, 1997).

environmental policies depends on the type of trade regime and on the magnitude of pollution leakages. In the absence of pre-existing international trade agreements, the presence of green lobbies always biases pollution taxes upwards. In this case, if the size of the lobbies is large enough, uncoordinated pollution taxes are closer to the efficient Pigouvian solution than internationally coordinated taxes. If, however, governments are bound by international trade rules, green lobbying could bias unilateral pollution taxes downwards. In this case, environmental policy coordination is unambiguously efficiency enhancing.

In Chapter 3, we extend the analysis to the case where both producer and environmental groups are organized. We characterize the policy outcomes and the relationship between lobbies in three alternative policy regimes: when governments control both trade and environmental policies; when they are restrained to the use of environmental policy by an existing free trade agreement; and when trade policy is the only available instrument.

We find that the *nature of the relationship between the two lobby groups depends on three factors: the type of policy regime, whether the decision-making process is centralized or decentralized, and the magnitude of the 'pollution leakages'.*

If trade and environmental policies are selected unilaterally and in isolation, and the resulting leakages effects are large enough, environmental and producer groups will be allied against a unilateral increase in domestic pollution taxes and in favor of protectionist trade policies.

In a regime in which both policy instruments are available, governments can eliminate pollution leakages by combining the use of pollution taxes (to reduce domestic emissions) and import tariffs (to avoid increasing foreign emissions). In this case, green and producer groups will unambiguously be allied over trade policy and competing over environmental policy. Our analysis also predicts that the interests of green and producer lobbies will always be divergent in international environmental negotiations, and that they will be convergent in international trade negotiations—when these are unaccompanied by efforts to reduce pollution.

To the best of our knowledge, our analysis is the only attempt to examine the *joint determination of trade and environmental policies.*[7] In our setup, trade and

[7] See Section 1.2.6 for a discussion of the existing literature on the political economy of trade and environmental policies.

environmental policies are fully linked: environmental regulations affect the pattern of comparative advantage; trade can generate adverse environmental effects, but at the same time provides a mechanism for mitigating them.

1.1.2 Trade and Environmental Negotiations

International relations involve *multiple dimensions of interaction.* Even when these dimensions are not directly interdependent—in the sense that the effects of choices along one dimension are dependent on choices along the others—there can still be cross-issue *negotiation* linkage: by exchanging concessions across different policy dimensions, countries may be able to achieve cooperation in situations where there would otherwise be no scope for mutual gains to be attained. Although this idea is not new,[8] its implications have so far only been examined in the context of bilateral negotiations, not multilateral negotiations.

The literature on international agreements has primarily been concerned with whether single-issue multilateral agreements are immune from the possibility of deviations by a subset of countries. Consistently with the single-issue nature of the problem it studies, this literature has built upon theories of coalition formation whereby members of a coalition coordinate *all* of their actions with other members.[9] Simply extending the concept of coalition structure to a multi-dimensional framework in order to characterize the viability of multilateral cooperation arrangements can be misleading, because it does not account for the fact that countries can (and often do) form selective arrangements with different partners over different issues.

In Chapter 4 of the thesis, we present a model of international policy coordination choices where *countries can enter into selective and separate binding agreements with different partners along different policy dimensions.* International relations are described as a two-stage game, in which agreements are formed in the first stage and policies are selected in the second stage, cooperatively among countries participating in an agreement and noncooperatively between countries belonging to separate agreements. In this model, a stable agreement structure is

[8] The point was first stressed by Raiffa (1982) and Sebenius (1983). For a recent application to North-South trade and environmental policy cooperation, see Abrego *et al.* (1997).

[9] For an extensive survey of this literature, see Bloch (1997).

reached if no subset of countries can credibly object to it.

The model is then used to examine the implications of negotiation tie-in—the requirement that agreements must span multiple dimensions of interaction—for the viability of multilateral cooperation, when countries are linked by emission spillovers and international trade under perfect competition. We show that, *while in some cases a tie-in constraint has no effect or makes multilateral cooperation more viable, in others it makes a viable joint multilateral agreement unstable.*

In Chapter 5, we use the model of multi-dimensional agreement formation developed in the previous chapter to study the formation of international trade agreements, when markets are imperfectly competitive and governments use two trade policy instruments (import tariffs and export subsidies) to affect the interactions between oligopolistic firms.

We employ a simple three-country model of intra-industry trade to examine whether preferential trade agreements are stepping stones or stumbling blocs towards the attainment of multilateral trade cooperation. We describe international trade relations as a three-stage process. In the first stage, countries decide whether or not to form cooperative trade agreements. These might take three forms: 'pure' customs unions (CUs), in which member countries eliminate tariffs among themselves and set a common external tariff to maximize their joint welfare[10]; agreements to coordinate the use of export subsidies only; and 'impure' CUs, involving the coordinated use of both policy instruments.[11] In the second stage, tariffs and subsidies are selected—cooperatively among countries participating in an agreement and non-cooperatively between countries belonging to separate agreements. In the last stage, firms compete in quantities.

From the analysis of the welfare implications and the stability of alternative agreement structures, we obtain the following results: (i) *three factors determine whether preferential trade agreements pose a threat to the multilateral trading system: which policy instruments are available, the degree of industry concentration, and the extent of product differentiation*; (ii) when both import tariffs and export

[10] An example of a 'pure' CU is provided by the Southern Common Market (MERCOSUR).

[11] The European Union can be considered an example of an 'impure' CU: its state aid policy restricts the capacity of national governments to support their firms and delegates to the Commission the task of ensuring that all subsidies granted within the EU are compatible with the single market objectives (Cini and McGowan, 1998).

tariffs are available, and the traded goods are homogeneous, 'impure' CUs are always stumbling blocs towards multilateral trade cooperation; (iii) when both policy instruments are available and firms sell nationally differentiated products, multilateral cooperation is sustainable only if the degrees of product differentiation and industry concentration are large enough; (iv) if policy-makers are banned from using export subsidies, the only stable negotiation outcome is global free trade. These findings provide a rationale for the recent attempts to strengthen international rules against the use of export subsidies.

1.1.3 Conclusions

Chapter 6 presents some concluding remarks and suggests some possible extensions to our work. Three broad themes emerge from the thesis. The first is that international relations involve *two distinct stages of strategic interaction*: in the first stage, political competition between the different interests determines the government's policy preferences; then the negotiations between national governments determine the international equilibrium. We believe that more research is needed to examine how economic policies, including trade and environmental policies, are determined by political and economic interests.

The second theme is that international relations involve the possibility of partial cooperation, in between the extremes of full cooperation and no cooperation. In our opinion, more attention should be devoted to study of the *conflicts* that are likely to emerge both *between and within coalitions of countries.*

Finally, our analysis points out that international negotiations involve *multiple dimensions of strategic interactions*, since they involve different policy issues (e.g. trade and environment) and policy instruments (e.g. import tariffs and export subsidies). Our analysis shows that focusing on single issues might be misleading, i.e. might result in drawing incorrect conclusions about the outcome of the negotiations.

1.2 The Debate on Trade and the Environment

The starting point of the current trade and environment debate was the 'Earth Summit' in Rio de Janeiro in 1992 and a series of environment-related trade

disputes, especially the 'tuna-dolphin' dispute between Mexico and the United States.[12] Following these disputes, a GATT/WTO Committee on Trade and the Environment was established at the 1994 Marrakesh meeting that concluded the Uruguay Round (see Whalley, 1996).

In this section, we briefly outline what we regard as the seven main issues in the trade and environment debate.[13] The research carried out in this thesis is mainly related to the last three issues.

1.2.1 Trade Liberalization and Environmental Quality

During the last decade, the moves towards to extending trade liberalization, such as the creation of the EC 92 internal market, the North American Free Trade Agreement (NAFTA) and the Uruguay Round of GATT negotiations, have stimulated an intense debate about the impact of the removal of trade barriers on the environment.

Some studies have argued that, unless corrective policies are taken, trade liberalization generates an increase in production and consumption activities. This damages the environment, through the associated increase in pollution and loss of natural resources (see, for example, Shrybman, 1990).

On the other hand, trade liberalization can improve environmental quality through three different channels: by raising incomes, so that there is more interest in, and more money to spend on, environmental protection; by providing countries with the access to new and cleaner technology; and by enhancing the allocative efficiency of environmental resources.

Among the papers which have expressed a more positive view of the linkage between trade openness and the environment is Antweiler *et al.* (1998), which

[12]The dispute was over the extra-territorial application of the US Marine Mammal Protection Act, which requires steps to be taken to curtail the incidental killing of marine mammals by commercial fishermen. In 1988 the US government introduced an import ban on tuna harvested in a way that did not satisfy the standards for the protection of dolphins applied to domestic fishermen. In 1991 a panel requested by Mexico ruled that the US ban was a violation of GATT article III, and that the Article XX exceptions in GATT could not be applied on an extra-territorial basis.

[13]Extensive reviews of the trade and environment debate include Anderson and Blackhurst (1992), Dean (1992), Carraro (1994), and Ulph (1999).

develops a theoretical model to divide trade's impact on pollution into scale, technique and composition effects. Using data on sulfur dioxide concentrations, they find that international trade creates relatively small changes in pollution concentrations when it alters the composition, and hence the pollution intensity, of national output. Their estimates of the associated technique and scale effects created by trade imply a net reduction in pollution from these sources. Combining estimates of scale, composition and technique effects, they conclude that trade liberalization appears to be good for the environment.

Empirical studies suggest that environmental policies and trade policies are not as interdependent as some appear to believe. Specifically, trade policy seems to have a very limited impact on the welfare effects of environmental policy (Perroni and Wigle, 1994).

A recent study by the WTO (1999) argues that there is no basis for the sweeping generalizations that trade openness is either bad or good for the environment. The environmental effects of trade liberalization are theoretically and empirically ambiguous, and depend on three interacting factors: (i) trade induced changes in industrial composition, and hence the pollution intensity of national output; (ii) changes in the overall scale of economic activity; and (iii) changes in production technology. Therefore the net outcome is a priori undetermined.

1.2.2 Trade Policy, Growth and the Environment

An important question relates to the more dynamic aspects of the relationship between trade liberalization and environmental quality.[14] Some empirical evidence suggests the existence of an environmental Kutznets curve (EKC), implying that pollution increases at the early stages of development but decreases after a certain income level has been reached. However, Barbier (1997) shows that the EKC hypothesis may be valid for some types of pollutants (e.g. urban air pollution and, to some extent, freshwater pollutants) but not for others (e.g. CO_2 emissions).

Grossman and Kreuger (1991) study the environmental impact of NAFTA, pointing out that a reduction in trade barriers will affect the environment in three ways: by expanding the scale of economic activity, by altering the composition of

[14] For an extensive review of the literature on the linkages between trade liberalization, growth and the environment, see WTO (1999).

economic activity, and by bringing about a change in the techniques of production. They present empirical evidence to assess the relative magnitudes of these three effects as they apply to further trade liberalization in Mexico. They also use comparable measures of three air pollutants in a cross-section of urban areas located in 42 countries to study the relationship between air quality and economic growth. They find that for two pollutants (sulfur dioxide and "smoke") concentrations increase with per capita GDP at low levels of national income, but decrease with GDP growth at higher levels of income.

Coopeland and Taylor (1994) develop a simple static model of North-South trade to examine linkages between national income, pollution, and international trade. Two countries produce a continuum of goods, each differing in pollution intensity. The authors show that the higher income country chooses stronger environmental protection and specializes in relatively clean goods. By isolating the scale, composition, and technique effects of international trade on pollution, they show that freer trade increases world pollution; an increase in the rich North's production possibilities increases pollution, while similar growth in the poor South lowers pollution; and unilateral transfers from North to South reduce global pollution. Coopeland and Taylor (1995), examine the interaction between pollution, income levels, and the patterns of trade in a general equilibrium setting. They find that free trade raises world pollution if incomes differ substantially across countries.

1.2.3 Migration of "Dirty" Industries

Another concern related to the trade-environment nexus is the so-called "pollution haven" hypothesis. The idea is that low environmental standards in developing countries compared to industrialized nations will lead "dirty" industries to migrate to these less developed countries (LDCs). In addition, LDCs may intentionally undervalue the environment in order to attract new investment.

Low and Yeats (1992) find that a more rapid growth of dirty industries in lower income countries. This may relate to several considerations, such as relative labor costs or natural resource endowments. Another possible explanation is that particular kinds of industries, which happen to be relatively dirty, predominate in early stages of industrial development.

Lucas *et al* (1992) find that stricter regulation of pollution intensive production in OECD countries "has led to significant locational displacement, with consequent acceleration of industrial pollution intensity in developing countries." However, Grossman and Kreuger (1993) find that the sectoral patterns of trade between the United States and Mexico have not been influenced by differences in pollution abatement costs.

A study by the WTO (1999) argues that little evidence seems to support the claim that polluting industries tend to migrate to LDCs to reduce environmental compliance costs. This is also in line with earlier studies surveyed by Pearson (1988).

1.2.4 Strategic Environmental Policy and International Trade

Another frequently expressed concern about open trade is that it will lead to competitive deregulation and least common denominator environmental standards or "eco-dumping" (Rauscher, 1994). The argument is that, if markets are imperfectly competitive, governments have incentives to relax their environmental policies to try to shift rents from foreign to domestic producers.[15]

Issues of strategic environmental policies have been introduced by Ulph (1992), who develops a three-stage model in which governments choose environmental policies in the first stage, and firms choose output levels and capital stocks in the second and third stages. He shows that, if governments behave strategically, they will use quantity standards instead if pollution taxes, since these allow firms to produce lower outputs, and thus earn higher profits.

Other studies have assumed that governments use emission taxes (Conrad (1993a,b) and Kennedy (1994) or emission standards (Barret, 1994a). Barret (1994a) focuses on two governments and their respective industries who sell their output in a third market. He shows that, if the two firms compete in quantities, each government has incentives to impose a "weak" environmental standard, such that the marginal damage from pollution exceeds the marginal cost of abatement. However, if the firms compete in prices, countries have incentives to impose

[15] For an extensive survey of the literature on strategic environmental policies, see Ulph (1999).

"strong" environmental standards, such that the marginal damage from pollution abatement is less than the marginal cost of abatement.

Ulph and Ulph (1996) have analyzed a situation in which firms can make pre-commitments for strategic purposes—such as investing in R&D designed to influence their costs in the market game. Firms' strategic behaviour can substitute in part for governments' strategic behaviour, but it also provides another avenue by which governments can use environmental policy to influence the market.[16]

1.2.5 Environmental Regulation and Competitiveness

Environmentally motivated taxes, subsidies, standards and other regulations can alter patterns of production and trade through their impact on international competitiveness. Theoretically, countries with more stringent environmental regulations could experience loss in comparative advantage (see Siebert, 1985). This explains the charge of "unfairness" which is often leveled against countries that derive a comparative advantage from lower environmental standards (see Nichols, 1997). However, most empirical studies suggest that the competitiveness effects of environmental regulations are minor for most industries (see Low [1992] and WTO [1999]).

Assuming that countries have identical production, pollution and abatement functions for a particular good, with free trade one would expect the country with relatively larger assimilative capacity to specialize in the production of the pollution intensive goods. That is, it is assumed that in autarky, the country richly endowed with assimilative capacity will have a price advantage in the pollution intensive good.

Unilateral imposition of environmental regulations by the environmentally rich country will impose some costs on its producers, thus eroding the price advantage relative to the foreign country. We should therefore expect a shift in specialization where the environmentally scarce country increases production of the pollution-intensive good. Thus, unilateral regulations not only change the patterns of trade, but also increase pollution in the other country - even when no transnational

[16] R&D investment has two effects: the *direct rent-shifting effect*, which unambiguously leads governments to relax environmental policy, and the *indirect strategic investment effect*, in that governments try to manipulate the R&D decisions of the firms. The overall effect is ambiguous.

pollution exists ("pollute thy neighbor via trade").

As discussed above, in Chapters 2 and 3 of this thesis we show that, when countries are large and pollution is transboundary, more stringent domestic environmental regulations imply that domestic firms experience a loss in comparative advantage; this leads to an increase in foreign emissions which the domestic residents dislike as well. To avoid these 'pollution leakages', a country must be able to combine the use of trade and environmental policy instruments.

1.2.6 The Political Economy of Trade and Environment

There exists an increasingly vast literature looking at the influence of interest groups on trade and environmental policy-making.

Some studies examine this issue from an empirical point of view. For example, VanGrasstek (1992) undertakes an analysis of the voting behaviour in the United States Senate. His econometric study establishes that voting on trade issues and on environmental issues can be linked to identifiable constituency interests. Senators are more likely to support trade restrictions which seek to protect the environment and environmental regulations that protect domestic producers. The evidence suggests that environmental considerations tend to increase the votes in favor of trade restrictions, so linking trade with environment would seem to make legislators more likely to support protectionist policies. The European experience explored by Klepper (1992) does not permit the kind of precise analysis of voting behaviour undertaken by VanGrasstek (1992) as a means of assessing the significance of the environment-trade link. This is because fewer issues are voted upon in European institutions and also because there is less transparency in decision-making than in the United States.

Most theoretical studies consider *only one policy instrument*. For example, Hillman and Ursprung (1992, 1994) investigate how environmental concerns might affect international trade policy. Another strand of the literature, which includes Hillman and Ursprung (1988), Grossman and Helpman (1994, 1995a,b) and Mitra (1999), examines how trade policy is affected by the presence of producer lobbies. Fredriksson (1997) and Aidt (1998) examine the effect of lobbying by green and producer groups on the determination of environmental policy.[17] Similarly to our

[17] Fredriksson (1997) incorporates into his model a pollution abatement subsidy, showing that

analysis, the last two studies use a common agency model of lobbying. However, since they focus on local environmental problems in a small open economy, they leave aside the issues of pollution spillovers, terms of trade effects and the need for international cooperation, which are central to our analysis.

As far as we know, the analysis contained in Chapters 2 and 3 of this thesis, described in Section 1.1.1 above, is the only attempt to examine the role of green lobbies on the *joint determination of trade and environmental policies* in the context of large open economies.

1.2.7 The Linkage between Trade and the Environment in Multilateral Negotiations

Much of the literature on international policy cooperation has *separately examined cooperation over trade policies and over environmental policies.* Riezman (1985), Krugman (1991), Bond and Syropoulos (1993), and Yi (1996), among others, have focused on the creation of customs unions (CUs), while Carraro and Siniscalco (1993a, 1994), Barrett (1994b) and Chander and Tulkens (1992), among others, have focused on International Environmental Agreements (IEAs). The broad theme emerging from this literature is that the presence of spillovers between coalitions (positive in the case of environmental coalitions, negative in the case of trade coalitions) makes global cooperation difficult to sustain, and that partial cooperation, restricted to subsets of countries, is more likely to emerge.

Coopeland and Taylor (1995) suggest that there are strategic reasons for *linking trade and environmental policies* in multilateral North-South negotiations. The asymmetric structure and distributions of the gains and losses across high and low income countries associated with each of these policy dimensions can make global cooperation easier to sustain when pursued through linked negotiations. On one hand, global environmental externalities provide developing countries with strategic leverage over the use of trade restrictions by developed countries against their own exports. On the other hand, developed countries can use trade policy

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pollution may be increasing in the pollution abatement subsidy rate. Aidt (1998) assumes that a production externality arises from the use of a factor input. His analysis generalizes Bhagwati's principle of targeting to distorted political markets: the most efficient instrument to internalize the externality is a tax on the polluting input factor, which aims directly at the source.

threats to achieve improved environmental management in developing countries (Abrego *et al.*, 1997).

In this context, it has been suggested that multilateral cooperation could be enhanced by formally combining different issues with the aim of joint settlement. The implicit, informal presumption in the policy debate seems to be that tie-in could "help" cooperation, by forcing asymmetric countries to trade concessions across different issues and by offsetting free-riding incentives. For example, Carraro and Siniscalco (1994) point out that free-riding incentives could be offset by making the signing of agreements entailing positive excludable externalities restricted to signatory countries (e.g. trade or R&D agreements) *conditional* on environmental cooperation. This argument is often heard in the policy debate.[18] It should be stressed, however, that the prevalent position in policy circles seems to be that the WTO should just accommodate the aims of the parties to multilateral environmental agreements (IEAs). This would require a new interpretation of WTO rules, or possibly even textual amendments to them, so as to legitimize the use of trade restrictions in accordance with IEAs such as the Montreal Protocol on Substances that Deplete the Ozone Layer[19] or the Kyoto Protocol on greenhouse gas emissions.[20]

In Chapter 4 of this thesis we describe a multi-dimensional agreement formation game. To our knowledge, this is the only attempt to study the *implication of issue-linkage in the context multilateral negotiations.*[21] We describe a three-country model of international trade with transboundary pollution to formally examine the question of whether negotiation tie-in across trade and environmental policy

[18] For example, the idea that trade cooperation should be made conditional on environmental cooperation is implicit in the proposal for an International Agreement on Trade and Environment (International Institute for Sustainable Development, 1996).

[19] The Montreal Protocol is a famous example of an multilateral environmental agreement which allows the use of trade sanctions as a way to deter environmental free-riding (see Barret, 1997).

[20] This latter approach is reflected in several speeches made at the WTO High Symposium on Trade and Environment held in Geneva from 15-16 March 1999, which are available on the WTO web site. For a discussion of issues related to the integration of IEAs within the GATT/WTO, see Esty (1994) and Brack (1997).

[21] The idea of issue-linkage was first stressed by Raiffa (1982) and Sebenius (1983) in the context of bilateral negotiations.

issues would help or hinder multilateral cooperation. We show that, while in some cases negotiation tie-in has either no effect or can make multilateral cooperation more viable, in others a formal tie-in constraint can make an otherwise viable joint multilateral agreement unstable.

1.3 The Debate on Regionalism versus Multilateralism

The question of 'regionalism', defined broadly as preferential trade agreements among a subset of nations, poses two sets of questions:

- What are the welfare implications of the formation of PTAs for member and non-member countries as well as for world welfare?

- Will regionalism lead to non-discriminatory multilateral free trade for all countries, through the continued expansion of PTAs or will it fragment the world economy?

Most studies have focused on the question of the static impact effects of PTAs. This was first addressed by Viner (1950) who, distinguishing between trade diversion and trade creation, showed that customs unions (CUs) and free trade areas (FTAs) were not necessarily welfare improving, either for member countries or for world welfare. In contrast to the Vinerian approach, Kemp and Wan (1976) make the external tariff structure endogeneously determined for the CU such that it improves the CU member's welfare while maintaining the outsiders' welfare unchanged. This restores the pre-Vinerain intuition that CU should be welfare-improving. However, as underlined by Richardson (1995), the result obtained by Kemp and Wan (1976) hinges on the assumption that countries behave non-optimally. If non-member countries optimally respond to the common external tariff (CET), CU members might be worse off than in the pre-union scenario.

The second question posed by regionalism has received much attention since Krugman (1991) suggested that the enlargement of CUs would lead to an increase in protection against countries outside each bloc, so that the world as a whole would be hurt by what appears to be a liberalizing step of promoting (preferential)

free trade.[22] To answer the so-called 'dynamic time-path question' it is necessary to examine whether forming a particular trade agreement is in the interest of the member states. Riezman (1985) was the first to model how states choose their agreement partners and analyze the structure of a stable CU. Using the Core as a solution concept but precluding the possibility of interstate tranfers[23], he concluded that global free trade might not be a stable outcome. The same conclusion is reached by Kennan and Riezman (1990), Kose and Riezman (1999)[24] and Burbidge *et al.* (1997).[25] All these studies are based on the assumption that trade occurs under perfect competition.

There has been little attempt to look at trade bloc formation in models of strategic trade policy. Sinclair and Vines (1994), have extended Brander and Spencer (1984)'s tariff model to consider the impact of the creation of CUs and free trade areas (FTAs) on the Nash equilibrium tariffs. However, they have not considered the welfare implication of trade bloc formation. In an infinitely repeated version of Brander and Spencer (1985)'s export subsidy game, Collie (1993) has shown that free trade can be sustained by the threat of retaliation with the Nash equilibrium export subsidies, provided that countries are similar and the discount factor is sufficiently high. A multi-country version of this model is employed by Collie (1997) to study the effects of trade bloc enlargement. Differently from our analysis, these studies treat the trade agreement structures as given, without

[22] In a monopolistically competitive framework in which provinces are divided into symmetric CUs, Krugman (1991) shows that a reduction in the number of CUs raises the Nash equilibrium tariff set by each bloc, and the world welfare is minimised when the world is divided into three symmetric blocs.

[23] Most theoretical studies on trade bloc formation rule out international income transfers. A notable exception is represented by Kowalczyk (1994).

[24] Kennan and Riezman (1990) and Kose and Riezman (1999) construct a pure exchange general equilibrium model with three countries and three goods, in which trade patterns are determined by comparative advantage considerations. Using simulation techniques to compare optimal tariffs and welfare gains in alternative agreement structures, they show that for certain endowment distributions CUs can pose a threat to the multilateral trading system, since, due to the improvement in their terms of trade, member countries can obtain larger welfare gains than at the free trade.

[25] Burbidge *et al.* (1997) describe an explicit model in which states choose their coalition partners and show that, with more than two states, incomplete federation might be the unique equilibrium, even allowing for cooperation and transfers within CUs.

modelling how states choose their agreement partners.

As discussed in Section 1.1.2, in Chapter 5 of this thesis we examine the endogenous formation of trade blocs under the assumption that markets are imperfectly competitive. We focus on the case of three ex-ante symmetric countries and assume that governments can use two trade policy instruments (import tariffs and export subsidies) to affect the interactions between firms. We find that preferential agreements involving the coordinated use of both import tariffs and export subsidies pose a threat to the sustainability of multilateral trade cooperation.

Our analysis presents some similarities with Yi (1996), who employs a multi-country extension of Brander and Spencer's (1984) tariff model to describe endogenous trade bloc formation under imperfect competition. He addresses the issue of the sustainability of global free trade under alternative rules of CU formation.[26] However, Yi (1996) assumes that import tariffs are the only available instrument and can thus reach a more optimistic conclusion about the sustainability of multilateral trade cooperation in the case of three ex-ante symmetric countries.

The issue that international tariff negotiations might be affected by the existence of alternative policy instruments has been raised in a number of studies. For example, Coopeland (1990) has analyzed the general case of bilateral tariff negotiations when there exist non-negotiable domestic policy instruments. Gatsios and Karp (1992) look at the imperfect harmonization of trade and industrial policies and note the possibility of welfare reducing preferential trade agreements when members coordinate only the use of tariffs. A similar result is obtained by Richardson (1994), who shows that the uncoordinated use of domestic taxes/subsidies can render a 'pure' CU unattractive. More recently, Richardson (1999), focusing on the interaction between trade and competition policies, finds that the formation of a CU improves members' welfare only if it goes beyond mere trade coordination. However, none of these studies has examined the endogeneous formation of trade blocs and the issue of the sustainability of multilateral trade cooperation.

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[26] Yi (1996) finds that CUs are stepping stones towards global free trade if membership of a trade agreement is open to all players, but they might be stumbling blocs towards free trade if the formation of a trade bloc requires the agreement of all potential members and the number of negotiating countries exceeds a critical value. In the case of three countries, he finds that global free trade is always sustainable.

Part I

The Political Economy of Trade and the Environment

Chapter 2

Can Green Lobbies Replace Environmental Policy Cooperation?

2.1 Introduction

In this chapter we examine how the presence of green lobbies can affect the determination of trade and environmental policies when countries are linked through trade flows and transboundary pollution.

Transboundary environmental problems involve pollution which is released in one country but causes damage in at least one other country. Some pollutants have a global geographical impact, like chlorofluorocarbons (CFC), halons and carbone dioxide (CO_2), which contribute to the depletion of the ozone layer and to climate change. Other pollutants have a regional impact, like sulphur dioxid, which is considered the main cause of acid rain.

In the presence of pollution spillovers, it is widely recognized that uncoordinated environmental regulation at the national level is associated with market failures and that efficiency requires environmental policy cooperation. In the absence of cooperation, there is a presumption that green lobbies might act as a partial remedy, by exerting political pressure in favor of higher domestic pollution taxes. In recent years, green lobbies have grown in size[1] and have become increasingly

[1] For example, in 1998 in the United States the *Environmental Defense Fund* had 151 perma-

important actors in environmental politics. They exercise pressure on national governments as well as on supra-national institutions such as the World Bank, the World Trade Organization or the EU (Charter and Deléage, 1998). They are also active participants in all international trade and environmental negotiations.[2]

In this chapter, we argue that, when applied to large countries, the presumption that green lobbies increase the efficiency of unilateral environmental policies could be misleading. The main argument is that a unilateral increase in emission taxes, if unaccompanied by an increase in import tariffs, will shift the comparative advantage of producing 'dirty' goods in favor of trading partners, leading to an increase in their emissions. The indirect effect of domestic policies on foreign emissions is known in the literature as "pollution leakage" (Copeland and Taylor, 2000). We show that, when emissions cross borders, the existence of pollution leakages reduces the incentives of environmental groups to lobby for higher domestic pollution taxes. If the pollution leakages and the emission spillovers are large enough, green lobbies could even support domestic tax reductions.

The objective of our analysis is to examine the impact of green lobbies on the determination of unilateral and cooperative policies in two different scenarios: when governments can use both trade and environmental policies; and when they are restricted to the use of environmental policies by existing international trade rules.

For this purpose, we employ a common agency model of politics of the kind introduced by Grossman and Helpman (1994). The bulk of our analysis is focused on the case in which governments are influenced by national green lobbies, but we also consider the case of an international green lobby. Lobbies confront incumbent politicians with contribution schedules, namely functions relating their binding promise of political support to the selected policies. Governments are

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nent staff and an annual budget of $23 m, *Greenpeace (US)* had 250 and $12 m, and the *Natural Resource Defense Counsel* 165 and $18 m.

[2]For example, at the Kyoto Conference on greenhouse emissions in December 1997, several green NGOs were represented (Greenpeace alone sent a 18-strong delegation). They "had considerable influence on the negotiations (and) served as sounding-board to assess how proposals would be received at home" (*Financial Times*, December 11, 1997). More recently, influential environmental groups such as *Friends of the Earth* launched a fierce campaign against the new round of GATT/WTO negotiations in Seattle (*The Economist*, December 11, 1999).

semi-benevolent, in that they choose trade and environmental policies so as to maximize a weighted sum of social welfare and total political contributions.

We focus our analysis on the case of two symmetric countries. This simplification allows us to abstract from the bargaining problems that would normally arise in the determination of the cooperative policies. It also enables us to compare the relative efficiency of unilateral and cooperative policy outcomes. The efficiency benchmark is represented by the adoption of Pigouvian taxes and free trade, i.e. the policies that would be selected by benevolent politicians acting in a cooperative manner. Since symmetric countries will always adopt identical import tariffs—which are equivalent to free trade— we are able to focus our analysis on the relative efficiency of the environmental policy outcomes, which we measure in terms of their distance from the optimal Pigouvian taxes.

We show that, when governments can use trade barriers to counteract the leakage effects of environmental policy, green interest groups would always lobby for higher pollution taxes. In this case, the comparative efficiency of unilateral and cooperative environmental taxes depends on the relative size of the green lobbies and the emission spillovers. However, if international trade rules restrain the possibility of trade intervention at the national level and the leakage effects of unilateral emission cuts are large enough, the impact of green lobbying on the environmental policy outcomes is ambiguous. In this case, the comparative efficiency of unilateral and cooperative environmental taxes depends on the relative size of the green lobbies, the terms-of-trade effects, and the emission spillovers.

Does the presence of green lobbies weaken the need for environmental policy cooperation? Our analysis suggests that the answer to this question depends crucially on the size of the pollution leakages and emission spillovers and on the degree of existing trade cooperation. At the international level, our results imply that the existence of a strong World Trade Organization (WTO) might require the need for a World Environmental Organization (WEO).[3] At the regional level, our analysis hints at the need for environmental cooperation among the members of preferential trade agreements such as the European Union, the North American Free Trade Agreement (NAFTA), the Southern Common Market (MERCOSUR)

[3]For a discussion of the arguments in favor of the creation of a WEO, see Newell and Whalley (2000).

or the Association of South East Asian Nations (ASEAN).

The possibility of emission leakages has received attention in the policy debate[4] and in various empirical studies on transboundary pollution. How important is the problem of the environmental policy leakages? The empirical literature is divided on this issue. Some simulation-based studies find that unilateral actions to curb CO_2 emissions would have relatively small adverse effects on other countries' emissions.[5] Other studies find that the emission leakages could be significant.[6] The reasons behind these contradictory results lie partly in the different assumptions about supply and demand elasticities, and partly in the general difficulties encountered in estimating actual emission spillovers.[7]

In spite of this debate, surprisingly, the theoretical literature on transboundary pollution[8] has largely ignored the problem of emission leakages.[9] In early work in this area, Markusen (1975a, 1975b) considers a model of two trading countries linked by a bilateral production externality. He characterizes optimal unilateral and cooperative trade and environmental policies, but does not consider the fact that, by unilaterally taxing its domestic firms, a country can encourage foreign production and emissions. More recently, Coopeland and Taylor (1995) have examined the interactions between pollution, income levels, and the patterns of trade in a general equilibrium setting. The bulk of their analysis is carried out under the assumption that countries are small, but they also consider the case of large coun-

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[4]For example, the attempt to mitigate the adverse effects of unilateral emission abatement has been the main reason for the proposal of tax exemptions on energy intensive industries by the European Commission (CEC, 1992).

[5]This is the conclusion reached, for example, by Olivera-Martins *et al.*(1992) and by a study of the Clinton Administration (1998) on the effects of the Kyoto Protocol. For a discussion, see Barret (1998).

[6]For example, Bernstein *et al* (1998) find that, for every 100 tons of carbon abated by the Annex I countries of the Kyoto Protocol, emissions in the other countries could rise by 5-10 tons. Significant leakage effects are also predicted by Nordhaus and Boyer (1998) and Manne and Richels (1998). An earlier study by IPCC (1996) finds that pollution leakages could be more substantial.

[7]See Missfeldt (1999) on this point.

[8]See Missfeldt (1999) for an extensive review of the game-theoretical literature on transboundary pollution.

[9]Exceptions are Merrifield (1988), Anderson (1992), and Copeland and Taylor (2000).

tries. However, since they ignore geographical considerations[10], they disregard the existence of pollution leakages.

In our analysis, trade and environment are fully linked: trade can generate adverse environmental effects, but at the same time provides a mechanism for mitigating them. In the vast literature on transboundary pollution, there is little work examining the extent to which *trade regimes* affect the link between optimal trade and environmental policies. The importance of the interaction between trade regimes and stringency of environmental regulation has been recognized in a number of studies. For example, Raucher (1994) shows that, if traditional trade policy instruments are not available, "ecological dumping" may arise: a country may have incentives to use too-lax environmental legislation as an instrument to shift the terms of trade in its favor. Fredriksson (1999) studies how environmental and industry lobbies can influence the determination of pollution taxes in sectors protected by tariffs. Taking the level of protectionism as given,[11] he finds that the level of political conflict on environmental policy falls with trade liberalization. Schleigh (1999) examines the joint determination of trade and environmental policies, assuming that the government has a single or a variety of domestic and trade policy instruments to address production or consumption externalities and to obtain political contributions from producer lobby groups. He shows that, in the presence of both trade and environmental distortions, inefficient trade policies can lead to higher environmental quality than more efficient domestic policies. Differently from our analysis, all these studies focus on a small economy and on local environmental problems and thus do not address the problem of pollution leakages.

Our analysis also contributes to an increasingly large political economy literature which examines the influence of interest groups on policy-making. To our knowledge, ours is the only study looking at the role of green lobbies on the *joint determination* of trade and environmental policies in the context of *large open economies*. Most studies consider only one of the policy instruments. For example, Hillman and Ursprung (1992, 1994) investigate how environmental concerns

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[10] Coopeland and Taylor (1995) assume that the environment is a *pure* good and that pollution is global, i.e. all countries are equally exposed to a given unit of emissions, regardless of its source.

[11] Fredrikkson (1999) compares an initial scenario which exogenously given tariffs with a free trade scenario. As noted by the author, this analysis only applies to small open economies with a negligible impact on multilateral trade talks.

might affect international trade policy,[12] while Fredriksson (1997) and Aidt (1998) examine the effect of lobbying by green and producer groups on the determination of environmental policy.[13] Similarly to our analysis, the last two studies use a common agency model of lobbying. However, since they focus on local environmental problems in a small open economy, they leave aside the issues of the emission spillovers, the leakage effects of environmental policy and the need for international cooperation, which are central to our analysis.

The remainder of the chapter is organized as follows. Section 2.2 describes the model. Section 2.3 examines the relative efficiency of unilateral and cooperative environmental policies in the absence of preexisting international trade agreements. Section 2.4 considers the case in which governments are bound by international trade rules and can only select environmental policies. In Section 2.5 we derive the unilateral and cooperative policy outcomes in the case where national governments are influenced by an international green lobby. Finally, Section 2.6 provides some concluding remarks.

2.2 The Model

2.2.1 The Economy

We begin by describing a simple model of international trade and transboundary pollution in which two countries, denominated home (no *) and foreign (*), produce and trade multiple goods. We will focus on the political and economic structure of the home country; the structure of the foreign country can be derived symmetrically.

There are $N + 1$ sectors, $i = 0, 1, \ldots, N$, where 0 denotes a numeraire good. All goods are produced with conventional constant returns to scale technology and

[12] Another strand of the literature, which includes Hillman and Ursprung (1988), Grossman and Helpman (1994, 1995) and Mytra (1999), among others, looks at how trade policy is affected by the presence of producer lobbies.

[13] Fredriksson (1997) incorporates into his model a pollution abatement subsidy, showing that pollution may be increasing in the pollution abatement subsidy rate. Aidt (1998) assumes that a production externality arises from the use of a factor input. His analysis generalizes Bhagwati's principle of targeting to distorted political markets: the most efficient instrument to internalize the externality is a tax on the polluting input factor, which aims directly at the source.

sold in perfectly competitive markets. The numeraire good is traded freely across countries and is produced using labor alone. We choose units so that its world and domestic price are equal to one. We assume that aggregate labor supply, L, is large enough to be able to produce a positive amount of good 0. This implies that in a competitive equilibrium the wage rate equals unity. The output of each non-numeraire good is given by the following production function:

$$Y_i = F(L_i, \bar{K}_i), \tag{2.1}$$

where L_i indicates the amount of labor used in the ith sector and $\bar{K}_i$ is a sector-specific capital, which is available in fixed supply.

Domestic consumer and producer prices of a non-numeraire good are given by q_i and p_i, respectively. International prices are denoted by π_i. With a wage rate equal to unity, the aggregate rent accruing to the specific factor in sector i depends only on the producer price of the good, i.e. $\Pi_i(p_i)$. By Hotelling's Lemma, industry supply is given by $Y_i(p_i) = \partial\Pi_i/\partial p_i$, where $\partial Y_i/\partial p_i > 0$, and $\partial Y_i/\partial p_i^2 \leq 0$.

For simplicity, we assume that the production of the numeraire good is 'clean', while production of a non-numeraire good i generates pollution emissions $E_i = \beta_i Y_i$, where β_i is an exogenously given emission coefficient.

The economy is populated by H individuals, $h = 0, 1, \ldots, H$, who have identical preferences. Preferences are quasilinear and additively separable. Individual h's utility can be written as

$$u_h(c_0, \ldots, c_N, Z) \equiv c_0 + \sum_{i=1}^{N} u_i(c_i) - Z, \tag{2.2}$$

where c_0 and c_i represent consumption of the numeraire and non-numeraire goods and $u(c_i)$ is assumed to be twice-differentiable, increasing, and strictly concave. The term Z captures total environmental damage, which is a function of domestic and foreign emissions: [14]

$$Z(\mathbf{p}, \mathbf{p}^*) \equiv \sum_{i=1}^{N} \Big[(1-\theta_i)E_i(p_i) + \theta_i E_i^*(p_i^*)\Big], \tag{2.3}$$

[14] In some cases, the concern about foreign emissions could derive from physical spillovers and be motivated by self-interest (e.g. ozone depletion, or carbon dioxide emissions); in other cases, it could derive from psychological spillovers and be motivated by aesthetic, altruistic or paternalistic reasons (e.g. foreign activities that endanger some species).

where $\mathbf{p}$ and $\mathbf{p}^*$ are vectors of producer prices, and $(1-\theta_i)$ and θ_i are the relative weights associated with domestic and foreign emissions in sector i, respectively. This specification captures different types of externalities: global environmental problems, whereby all countries are equally exposed to a given unit of pollution ($\theta_i = \theta_i^* = 1/2$); regional environmental problems ($0 < \theta_i < 1/2; 0 < \theta_i^* < 1/2$);[15] local environmental problems that generate no transboundary pollution ($\theta_i = \theta_i^* = 0$).

The government sets trade and environmental policies, which are restricted to two policy instruments: specific import tariffs or subsidies ($\boldsymbol{\tau}$), and environmental taxes or subsidies ($\mathbf{t}$).[16]

The demand function for good i can be expressed as a function of price alone, i.e. $D_i(q_i)$. The indirect utility function corresponding to (2.2) can be obtained as follows:

$$\begin{aligned} V_h(\mathbf{q},\mathbf{p},\mathbf{p}^*) \quad &\equiv L_h + \sum_{i=1}^{N} \lambda_i^h \Pi_i(p_i) + \frac{1}{H}\sum_{i=1}^{N} t_i Y_i(p_i) + \frac{1}{H}\sum_{i=1}^{N} \tau_i \Big[D_i(q_i) - Y_i(p_i)\Big] \\ &+ \sum_{i=1}^{N} u\Big(D_i(q_i)\Big) - \sum_{i=1}^{N} q_i D_i(q_i) - Z(\mathbf{p},\mathbf{p}^*). \end{aligned} \tag{2.4}$$

The first three terms represent income, which consumer h receives from three sources. First, she supplies her endowment of labor to the competitive market, receiving the wage income L_h. Second, she owns a share λ_i^h of a specific capital in sector i. Third, she receives $1/H$ of environmental and trade revenues, as a lump sum transfer. The next two terms represent consumer surplus and the last is environmental damage.

Trade and environmental policies drive a wedge between consumer and producer prices and between domestic and international prices, respectively. Consumer prices are thus equal to $q_i = \pi_i + \tau_i$, while producer prices are given by $p_i = \pi_i + \tau_i - t_i$. Net imports of good i in the home country are $M_i = D_i(q_i) - Y_i(p_i)$, and those in the foreign country are $M_i^* = D_i^*(q_i^*) - Y_i^*(p_i^*)$. World product markets

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[15] Some regional environmental problems, such as pollution of river systems, are unidirectional, i.e. emissions produced by "upstream" countries negatively effect "downstream" countries, without any significant reverse emission flows (see Silva, 1997).

[16] Then $t_i > 0$ ($t_i < 0$) represents an environmental tax (subsidy) on good i, and $\tau_i > 0$ ($\tau_i < 0$) indicates an import tariff (subsidy).

clear when

$$M_i(\pi_i, \tau_i, t_i) + M_i^*(\pi_i, \tau_i^*, t_i^*) = 0. \tag{2.5}$$

From (2.5) we can derive an expression for world equilibrium prices as a function of the policies in the two countries, i.e. $\pi_i(t_i, \tau, t_i^*, \tau_i^*)$.

2.2.2 The Political Arena

In order to isolate the impact of green lobbying on the determination of trade and environmental policy, we assume that only a fraction s^E of the citizens, the 'environmentalists', are organized in an interest group.[17]

We shall also assume that green lobbies are functionally specialized, i.e. their members are ideologically motivated and are only concerned with environmental protection.[18]

In the bulk of our analysis, we will consider a scenario in which environmentalists are organized in two national lobbies that act non-cooperatively. The case in which national lobbies coordinate their actions, acting as one international green lobby, is considered in Section 2.5.

Lobbies influence government action by setting a contribution schedules $C_i(t_i, \tau_i)$ that link their political support to the selected policies. Contributions should be interpreted broadly as bribes, campaign funds, or support demonstrations, to reflect different strategies used by green lobbies (Charter and Deléage, 1998). The contribution schedules will not be formal contracts, nor will they be explicitly announced. However, the government will know that an implicit link exists between the way it treats the environmentalists and the contributions it can expect to receive from that group.[19]

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[17] In the next chapter, we extend the analysis to the case in which both green and producer lobbies influence the determination of trade and environmental policies.

[18] Aidt (1998) distinguishes between functionally specialized interest groups and interest groups with multiple goals.

[19] The implicit assumption is that the lobby keeps its promise. It is hard to achieve this commitment in a one-shot game, but in a dynamic context reputation considerations could enforce it.

The gross (of contributions) welfare of the national green lobby is

$$W^{NE}(\mathbf{t},\boldsymbol{\tau},\mathbf{t}^*,\boldsymbol{\tau}^*) \equiv B - s^E H \sum_{i=1}^{N}\Big[(1-\theta_i)E_i(t_i,\tau_i,t_i^*,\tau_i^*) + \theta_i E_i^*(t_i^*,\tau_i^*,t_i,\tau_i)\Big], \tag{2.6}$$

where B is a constant. The green lobby submits contribution schedules $C_i(t_i,\tau_i;t_i^*,\tau_i^*)$ that maximize

$$\tilde{W^{NE}}(\mathbf{t},\boldsymbol{\tau},\mathbf{t}^*,\boldsymbol{\tau}^*) = W^{NE}(\,\mathbf{t},\boldsymbol{\tau},\mathbf{t}^*,\boldsymbol{\tau}^*) - \sum_{i=1}^{N} C_i(t_i,\tau_i;t_i^*,\tau_i^*). \tag{2.7}$$

The implicit objective of incumbent politicians is to be reelected.[20] This implies that they care about the utility level achieved by the median voter, particularly if voters are well informed about the effects of government policy and base their vote partly on their standard of living. Incumbent politicians also value political contributions for financing future campaigns and deterring competitors. Trade and environmental policies are thus chosen so as to maximize

$$G \equiv aW(\mathbf{t},\boldsymbol{\tau},\mathbf{t}^*,\boldsymbol{\tau}^*) + \sum_{i=1}^{N} C_i(t_i,\tau_i;t_i^*,\tau_i^*), \qquad a \geq 0, \tag{2.8}$$

where a is the government's weighting of social welfare compared to campaign contributions.[21] Domestic welfare is defined as aggregate domestic income, including tax and tariff revenues, plus total consumer surplus minus environmental damage:

$$\begin{aligned} W(\mathbf{t},\boldsymbol{\tau},\mathbf{t}^*,\boldsymbol{\tau}^*) \;\equiv\; & L + \sum_{i=1}^{N} R_i(t_i,\tau_i,t_i^*,\tau_i^*) + \sum_{i=1}^{N} t_i Y_i(t_i,\tau_i,t_i^*,\tau_i^*) + \sum_{i=1}^{N} \tau_i M_i(t_i,\tau_i,t_i^*,\tau_i^*) \\ & + H\Big[\sum_{i=1}^{N} u\Big(D_i(t_i,\tau_i,t_i^*,\tau_i^*)\Big) - \sum_{i=1}^{N} q_i D_i(t_i,\tau_i,t_i^*,\tau_i^*)\Big] - HZ(\mathbf{t},\boldsymbol{\tau},\mathbf{t}^*,\boldsymbol{\tau}^*). \end{aligned} \tag{2.9}$$

In order to derive the equilibrium cooperative policies, we also need to define the objective function of a mediator or supra-national government. As discussed

[20] See Grossman and Helpman (1996) for an explicit treatment of the electoral stage.

[21] As noted by Grossman and Helpman (1994), the welfare function of the government could be written as $\tilde{G} = a_1\mathbf{C} + a_2(W - \mathbf{C})$, where a_1 represents the weight that the politicians attach to campaign contributions and a_2 is the weight attached to *net* social welfare. Maximizing $\tilde{G}$ is equivalent to maximizing G in (2.8) with $a = a_2/(a_1 - a_2)$, provided $a_1 > a_2$.

by Grossman and Helpman (1995a), the outcomes of international negotiations must have the efficiency property that G could not be raised without lowering G^*. This implies that the cooperative policies are chosen so as to maximize the weighted sum

$$G^W = a^*G + aG^* = a^*a\Big[W(\mathbf{t},\boldsymbol{\tau},\mathbf{t}^*,\boldsymbol{\tau}^*) + W^*(\mathbf{t}^*,\boldsymbol{\tau}^*,\mathbf{t},\boldsymbol{\tau})\Big] + a^*\sum_{i=1}^{N} C_i(t_i,\tau_i,t_i^*,\tau_i^*) + a\sum_{i=1}^{N} C_i^*(t_i^*,\tau_i^*,t_i,\tau_i). \quad (2.10)$$

Thus the equilibrium policies are the same that would arise if a single decision maker had the preferences given on the right hand side of (2.10) and the organized green lobbies bid to influence this agent's decisions.

Equation (2.10) stipulates that cooperative policies must be efficient for the two governments without specifying how the surplus will be divided between them. In general, the determination of cooperative trade and environmental policies will involve a conflict of interest between the two countries. To determine which utility pair (G, G^*) will be selected on the straight line described by (2.10), a bargaining procedure must be introduced.[22]

We model political competition as a two-stage common agency game. In the first stage, green lobbies unilaterally or cooperatively confront politicians with their contribution schedules, which are assumed to be continuous and differentiable, at least around the equilibrium. In the second stage, governments (unilaterally or cooperatively) set trade and environmental policies and receive the corresponding political contributions. The problem is solved by working backwards, from the last stage to the first.

An equilibrium of a common agency game must be efficient for both the principals (green lobbies) and the agent (the incumbent national or supra-national government). The existence of such an equilibrium has been demonstrated by Bernheim and Whinston (1986). We leave out its derivation, which can be found in Grossman and Helpman (1994, 1995a), Dixit (1996) and Fredriksson (1997).

Following Bernheim and Whinston (1986), we focus on 'truthful' equilibria, where lobbies make contributions up to the point where the resulting change in

[22] One could adopt the Nash bargaining solution or, as in Grossman and Helpman (1995a), the Rubinstein's bargaining solution. In Sections 2.3-2.5, we will assume away the existence of bargaining problems by focusing on the case of two symmetric countries.

economic policies is exactly offset by the marginal cost of the contributions.[23] For the derivation of unilateral and cooperative equilibrium policies, see Appendix A.

2.2.3 The Problem of Pollution Leakages

The model described above is characterized by the existence of terms of trade and emission spillover effects. We now want to show that these effects combined generate the problem of pollution leakages: by increasing world prices, a unilateral increase in domestic pollution taxes will shift the terms of trade in favour of the non-implementing country, leading to an increase in its emissions, which the domestic residents dislike as well.

Formally, an increase in t_i[24] has the following impact on the international price

$$\frac{\partial \pi}{\partial t} = -\frac{Y_p}{M\prime + M^{*}\prime} \equiv \delta, \tag{2.11}$$

where $M\prime = D_q - Y_p$, with $Y_p = \partial Y/\partial p$ and $D_q = \partial D/\partial q$. Notice that $0 < \delta < 1$, i.e. higher domestic pollution taxes imply an increase in world prices and a shift in the terms of trade in favour of the foreign country. In this case, an increase in domestic environmental taxes has an ambiguous effect on domestic pollution:

$$\frac{\partial Z}{\partial t} = -(1-\theta)\beta Y_p(\delta - 1) + \theta\beta^{*}Y_p^{*}\delta. \tag{2.12}$$

The first term in (2.12) captures the environmental benefits associated with the fall in domestic emissions; the second term represents the environmental costs due to the increase in transboundary foreign emissions, which are increasing in the size of the emission spillovers and the pollution leakages. Therefore a unilateral increase in pollution taxes, if unaccompanied by the use of import tariffs, can only reduce domestic pollution at the cost of increased foreign pollution and is thus potentially damaging to the environment.

As it will emerge from the remainder of the chapter, the impact of green lobbying on the environmental policy outcomes will be ambiguous in the presence

[23] Bernheim and Whinston (1986) show that only truthful contributions yield coalition-proof Nash equilibria.

[24] Since consumer utility is quasilinear and additively separable, the $N+1$ sectors do not interact with each other, i.e. consumers do not substitute between goods from different sectors. We can then focus our analysis on a representative sector i of the economy. For notational simplification, in the remainder of the chapter we omit the sectoral subscript.

of pollution leakages. Since pollution leakages can be eliminated either through the use of import tariffs or through environmental policy coordination, the role of green lobbying will depend crucially on whether or not governments are bound by free trade rules, and on whether they act in a unilateral or cooperative manner.

2.3 Trade and Environmental Outcomes

In the following two sections, we examine the policies that emerge when governments act under the influence of national green lobbies. In this section, we consider the case where governments can set both trade and environmental policy, while in the next section, we will examine the case where, having already committed to free trade, they can only select environmental policies.

We focus on the case of two symmetric countries. This simplification presents two main advantages: it makes it possible to abstract from the bargaining problems that would normally arise in the determination of the cooperative policies; and it allows us to compare the relative efficiency of alternative policy outcomes.

The efficiency benchmark is represented by the policies that would be chosen cooperatively by benevolent politicians. Under the assumption of symmetry, these are given by

$$\tau = \tau^* = 0, \tag{2.13}$$

$$t_P = t_P^* = \beta H. \tag{2.14}$$

Thus the social optimum requires free trade and the adoption of the efficient Pigouvian taxes t_P. It is important to notice that, when the two countries are symmetric, they will always select identical import tariffs. Consequently, in equilibrium there will be no trade, independently of the policies adopted. Domestic prices, world prices and industry outputs will be the same as in free trade and there will be no allocative distortions other than those associated with uninternalized externalities. This allows us to focus on the comparative efficiency of the environmental policy outcomes, which we characterize in terms of their distance from the optimal Pigouvian taxes.[25]

[25] If the policies lie on the same side of the optimum, the distance from the Pigouvian taxes

2.3.1 Trade and Environmental Wars

Let us first consider the case where governments set their policies independently. Substituting the partial derivatives obtained from (5.2) and (2.6) into the first-order conditions for non-cooperative political equilibria, we can derive the following expressions for unilateral policies:

$$\tau_{NC} = \tau^*_{NC} = \frac{\beta H(a + s^E)\theta Y_p}{a(Y_p - D_q)}. \tag{2.15}$$

and

$$t_{NC} = t^*_{NC} = \frac{\beta H(a + s^E)(1 - \theta)}{a}, \tag{2.16}$$

Notice that, as green lobbies become larger and more influential (as s^E increases and a decreases), both equilibrium tariffs and pollution taxes increase. The following result follows immediately from (2.16):

Lemma 2.1 *In the case of two symmetric countries that are not bound by a free trade agreement, uncoordinated environmental taxes are socially optimal if and only if* $s^E = a\theta/(1 - \theta)$. *In this case, the domestic political distortion (green lobbying) exactly offsets the international environmental distortion (emission spillovers).*

PROOF: Given $s^E = a\theta/(1 - \theta)$, unilateral environmental taxes coincide with the Pigouvian taxes, i.e. $t_{NC} = t_P = \beta H$. Q.E.D.

2.3.2 Trade and Environmental Talks

International trade and environmental negotiations lead to the adoption of the following cooperative policies:

$$\tau_C = \tau^*_C = 0, \tag{2.17}$$

and

$$t_C = t^*_C = \frac{\beta H(a + s^E)}{a}. \tag{2.18}$$

The following result immediately follows from the analysis of (2.18):

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can be unambiguously interpreted as a welfare measure. This is also the case for policies that lie on different sides of the optimum, if the welfare function is symmetric with respect to the environmental tax.

Lemma 2.2 *In the case of two symmetric countries that are not bound by a free trade agreement, internationally coordinated pollution taxes are always higher than optimal.*

PROOF: From (2.18), it is straightforward to verify that cooperative taxes can only coincide with the Pigouvian taxes if $s^E = 0$, i.e. if no citizen is a member of the green lobby. For $s^E > 0$, $t_C > t_P$. Q.E.D.

Combining Lemmas 2.1 and 2.2, it is evident that efficient Pigouvian taxes can only be achieved in an uncoordinated framework. However, the question we really want to address is one of second-best nature: would the environmental policies set by individual governments be more or less efficient than those set by a supra-national authority? The comparison between (2.16) and (2.18) allows us to state our first proposition:

Proposition 2.1 *If governments are not bound by international trade rules, environmental policy coordination is efficiency enhancing if and only if* $s^E < a\theta/(2-\theta)$;

PROOF: When both trade and environmental policies are available, we can distinguish two cases:

1. If $s^E > \frac{a\theta}{1-\theta} \Rightarrow t_C > t_{NC} > t_P$;
2. If $s^E < \frac{a\theta}{1-\theta} \Rightarrow t_C > t_P > t_{NC} > 0$. There are two subcases:
   (a) $(t_P - t_{NC}) < (t_C - t_P) \iff s^E > \frac{a\theta}{2-\theta}$;
   (b) $(t_P - t_{NC}) > (t_C - t_P) \iff s^E < \frac{a\theta}{2-\theta}$.

Thus cooperative taxes are closer to the optimal Pigouvian solution than unilateral taxes if and only if $s^E < \frac{a\theta}{2-\theta} < \frac{a\theta}{1-\theta}$. Q.E.D.

The intuition behind Proposition 2.1, is the following: at the decentralized level, the bias towards higher pollution taxes caused by the political distortion (green lobbying) counteracts the bias towards lower pollution taxes caused by the environmental distortion (environmental spillovers); at the level of international negotiations, however, green lobbying distorts upwards policies that would otherwise be optimal. Therefore the comparative efficiency of unilateral and cooperative outcomes depends on the relative size of the two types of distortions.

2.4 Environmental-only Outcomes

Next, we examine the comparative efficiency of non-cooperative and cooperative environmental policy outcomes, assuming the two governments have already committed to trade policy coordination. This scenario could apply to members of a regional trade agreement like the European Union and the North American Free Trade Agreement (NAFTA) or to countries that are effectively bound by GATT/WTO rules.[26]

2.4.1 Environmental Wars

Equilibrium environmental policies emerging from decentralized decision-making are given by

$$\tilde{t}_{NC} = \tilde{t}^*_{NC} = \frac{\beta H(a+s)(\delta+\theta-1)}{a(\delta-1)}. \tag{2.19}$$

Comparing equation (2.14) and (2.19), we obtain the following result:

Lemma 2.3 *When two symmetric governments are bound by a free trade agreement, uncoordinated environmental policies are socially optimal if and only if national green lobbies have size* $s^E = a\theta/(1-\delta-\theta)$.

PROOF: The distance between the Pigouvian taxes and the equilibrium non-cooperative taxes is given by

$$\tilde{t}_{NC} - t_P = \frac{\beta H\Big[a\theta + s^E(\delta+\theta-1)\Big]}{a(\delta-1)}. \tag{2.20}$$

Setting expression (2.20) equal to zero and solving for s^E, we find that unilateral policies are equal to the first-best if

$$s^E = \frac{a\theta}{1-\delta-\theta}. \tag{2.21}$$

Pollution taxes will be higher (lower) than optimal if s^E is larger (smaller) than this critical size. Q.E.D.

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[26] It could be argued that the application to members of regional trade agreements is more appropriate in the case of regional environmental problems (i.e. $0 < \theta < 1/2$), while the application to GATT/WTO members is more suitable in the case of global pollution (i.e. $\theta = 1/2$).

The most striking result emerging from the analysis of (2.19) is described by the following proposition:

Proposition 2.2 *When two symmetric governments are bound by a free trade agreement, national green lobbying can create a bias towards lower domestic pollution taxes.*

PROOF: An increase in the size of the green lobby has the following impact of the equilibrium unilateral pollution taxes:

$$\frac{\partial \tilde{t}_{NC}}{\partial s^E} = \frac{\beta H(\delta + \theta - 1)}{a(\delta - 1)}, \tag{2.22}$$

which is negative if $\delta + \theta > 1$. This implies that, if the leakage effects of environmental policy and the emission spillovers are large enough, green lobbying could bias pollution taxes downwards. To understand this result, consider the effect of a unilateral increase in the home country's emission tax on the welfare of the national green lobby:

$$\frac{\partial W^{NE}}{\partial t} = -s^E H \beta Y_p (\delta + \theta - 1). \tag{2.23}$$

If $\delta + \theta > 1$, (2.23) is negative, implying that the green lobby will favor lower domestic pollution taxes. Q.E.D.

Notice that, if $\delta + \theta > 1$, the non-cooperative environmental taxes will actually be negative. This implies that, if the leakages effects of environmental policy and the emission spillovers are large enough, governments could end up subsidizing their domestic producers.

Proposition 2.2 is in contrast with the results obtained by Fredriksson (1997) and Aidt (1998) who, focusing on a small open economy and on local pollution problems, find that green lobbying unambiguously leads governments to adopt higher pollution taxes. Our analysis shows that, when countries are large and pollution is transboundary, the support of green lobbies for higher domestic pollution taxes can be weaker, due to the existence of pollution leakages. The larger are the leakage effects of environmental policy and the emissions spillovers, the weaker the green lobbies' support for stricter domestic policies will be. In the extreme case described by Proposition 2.2, green lobbies could even favor unilateral reductions in pollution taxes.

2.4.2 Environmental Talks

The first-order conditions for cooperative environmental equilibrium policies yield the same equilibrium policies as in equation (2.18):

$$\tilde{t}_C = \tilde{t}_C^* = \frac{\beta H(a + s^E)}{a}. \tag{2.24}$$

Therefore Lemma 2.2 also applies to the case in which governments have previously committed to trade policy coordination.

Notably absent from (2.24) are is the coefficient δ. This is because, when the decision-making process is centralized, the terms-of-trade effects of environmental policies—and thus the pollution leakages—are internalized. This explains why in this scenario green lobbying always creates a bias towards higher cooperative pollution taxes ($\frac{\partial \tilde{t}_C}{\partial s^E} > 0$).

The comparison between (2.19) and (2.24) allows us to state the following result:

Proposition 2.3 *When two symmetric governments are bound by international trade rules, environmental policy coordination is efficiency enhancing if and only if* $s^E < a\theta/(2 - \theta - 2\delta)$.

PROOF: When governments are bound by free trade rules, we can distinguish three cases:

1. If $\delta + \theta < 1$ and $s^E > \frac{a\theta}{(1-\theta-\delta)} \Rightarrow t_C > t_{NC} > t_P$;
2. If $\delta + \theta < 1$ and $s^E < \frac{a\theta}{1-\theta-\delta} \Rightarrow t_C > t_P > t_{NC} > 0$. There are two sub-cases:
   (a) $(t_P - t_{NC}) < (t_C - t_P) \iff s^E > \frac{a\theta}{2-\theta-2\delta}$;
   (b) $(t_P - t_{NC}) > (t_C - t_P) \iff s^E < \frac{a\theta}{2-\theta-2\delta}$;
3. If $\delta + \theta > 1 \Rightarrow t_C > t_P > 0 > t_{NC}$ and $(t_P - t_{NC}) > (t_C - t_P)$.

Thus cooperative taxes are closer to the optimal Pigouvian solution than non-cooperative taxes if and only if $s^E < \frac{a\theta}{2-\theta-2\delta} < \frac{a\theta}{1-\theta-\delta}$. Q.E.D.

2.5 The Case of an International Green Lobby

In the previous two sections, we have examined how national green lobbies influence the determination of unilateral and cooperative trade and environmental policies. Focusing on the case of two symmetric countries we have shown that, when governments are allowed to use both policy instruments, green lobbying always creates a bias towards higher pollution taxes. However, in a situation where governments are bound by free trade rules, unilateral efforts to reduce pollution by taxing domestic producers lead to an increase in foreign emissions, which the domestic residents dislike as well; if the pollution leakages and the emission spillover are large enough, green lobbying might actually create a bias towards the adoption of lower domestic pollution taxes.

In this section, we examine the policy outcomes that emerge when national green lobbies coordinate their actions, forming an international green lobby[27] which offers political contributions to both governments.[28] The utility of the international green lobby is simply the sum of the utilities of the two national green lobbies:

$$W^{IE}(\mathbf{t},\boldsymbol{\tau},\mathbf{t}^*,\boldsymbol{\tau}^*) \equiv \quad B^W - \sum_{i=1}^{N}\left[s^E H(1+\theta_i) + s^{E*}H^*\theta_i^*\right]E_i(t_i,\tau_i,t_i^*,\tau_i^*)$$
$$- \sum_{i=1}^{N}\left[s^{E*}H^*(1+\theta_i) + s^E H\theta_i\right]E_i^*(t_i^*,\tau_i^*,t_i,\tau_i), \quad (2.25)$$

and $B^W = B + B^*$. Notice that in the case of global pollution ($\theta_i = \theta_i^* = 1/2$), the international green lobby cares equally about emissions in the two countries.[29] It is easy to verify that the same result is also achieved when pollution is less transboundary, as long as each country is equally exposed ($\theta_i = \theta_i^*$) and the number of environmentalists in the two countries is the same ($s^E H = s^{E*}H^*$).

The international green lobby influences the determination of domestic and foreign policies, by offering political contributions to both governments. Its objective

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[27] The analysis of this section could apply to an environmental interest group like *Greenpeace*, which is formed by 41 internationally coordinated national lobbies (see www.greenpeace.org).

[28] We rule out corner solutions, situations in which political contributions are concentrated are offered to one of the two governments only.

[29] In Hillman and Ursprung (1992, 1994)'s terminology, this would be the case of 'supergreens'.

function is given by

$$\tilde{W^{IE}} = W^{IE}(\mathbf{t}, \boldsymbol{\tau}, \mathbf{t}^*, \boldsymbol{\tau}^*) - \sum_{i=1}^{N} C_i(t_i, \tau_i; t_i^*, \tau_i^*) - \sum_{i=1}^{N} C_i^*(t_i^*, \tau_i^*; t_i, \tau_i). \quad (2.26)$$

Table 2.1 reports the equilibrium unilateral and cooperative environmental policies for the two trade policy regimes, under the assumption of country symmetry.[30]

Table 2.1: Equilibrium Policies in the Case of an International Green Lobby

Policy Regime	Policy-making Process	
	Decentralized	Centralized
Trade and Environment	$\tau_{NC} = -\frac{\beta H\left[s^E(1+2\theta)+a\theta\right]}{aM'}$ $t_{NC} = \frac{\beta H\left[a(1-\theta)+s^E(1+2\theta)\right]}{a}$	$\tau_C = 0$ $t_C = \frac{\beta H\left[a+s^E(1+2\theta)\right]}{a}$
Environment	$\tilde{t}_{NC} = \frac{\beta H\left[a(\delta+\theta-1)+s^E(1+2\theta)(2\delta-1)\right]}{a(\delta-1)}$	$\tilde{t}_C = \frac{\beta H\left[a+s^E(1+2\theta)\right]}{a}$

The more interesting result emerging from the analysis of Table 2.1 is that the counterintuitive result of Proposition 2.2 still holds when national green lobbies act cooperatively:

Proposition 2.4 *When two symmetric governments are bound by a free trade agreement, international green lobbying can create a bias towards lower domestic pollution taxes.*

[30] These are derived using the equilibrium conditions given in Appendix A, for the case in which $I^{IE} = 1$, $I_{NE} = I_{NE}^* = 0$.

PROOF: in the scenario in which the two governments are under a free trade regime and select pollution taxes unilaterally, the influence of the international green lobby on the environmental policy outcomes is captured by

$$\frac{\partial \tilde{t}_{NC}}{\partial s^E} = \frac{\beta H(2\delta - 1)(1 + 2\theta)}{a(\delta - 1)}. \tag{2.27}$$

It is straightforward to verify that expression (2.27) is negative if $\delta > 1/2$. Hence, an increase in the influence of environmental groups—even when they act as an international green lobby—does not guarantee that environmental policy will be stricter. Q.E.D.

The intuition behind Proposition 2.4 is that a unilateral increase in domestic pollution taxes, if unaccompanied by an increase in import tariffs, will shift the terms of trade in favor of the foreign country and lead to an increase in foreign emissions. Therefore, while the problem of the pollution leakages can be eliminated through international coordination between national governments, it cannot be eliminated through international coordination between national green lobbies.

2.6 Concluding Remarks

In this chapter we have proposed an analytical framework to investigate how the presence of green lobbies can influence the comparative efficiency of unilateral and cooperative environmental policies. We have focused on the case of two large symmetric countries that are linked through trade flows and transboundary pollution.

The main results of our analysis can be summarized as follows:

- The impact of green lobbies on the comparative efficiency of unilateral and cooperative environmental policies depends on the type of trade regime and on the size of the pollution leakages and the emission spillovers;
- If, however, governments are bound by international trade rules, and the pollution leakages and the emission spillovers are large enough, green lobbying could actually bias unilateral pollution taxes downwards;
- In the absence of preexisting international trade agreements, the presence of green lobbies always biases pollution taxes upwards.

Does the presence of green lobbies weaken the need for environmental policy coordination? Our analysis suggests that the answer to this question depends crucially on the degree of trade policy cooperation. On the one hand, countries that have not committed to trade cooperation might find it more efficient to choose policies in a unilateral manner. On the other hand, countries that are already cooperating over trade policy could gain by coordinating their environmental policies too, at least in those sectors of the economy where there are large pollution leakages.

These results have important international and regional implications. At the international level, the existence of GATT/WTO rules which restrict governments' ability to use trade barriers would suggest the need for the creation of a WEO. However, if GATT/WTO rules are not binding[31] unilateral policy-making could lead to more efficient policy outcomes. At the regional level, our analysis hints at the need for environmental cooperation among the members of preferential trade agreements such as the E.U., NAFTA, MERCOSUR and ASEAN.[32]

The analytical framework described in this chapter is highly simplified and the results obtained must be interpreted with great caution. More work is needed to examine how economic policy, including environmental policy, is determined by political and economic interests.

First, the common agency approach leaves two crucial issues aside: it does not explain why only some groups of citizens overcome the free-rider problem of collective action described by Olson (1965) and become politically organized; and it does not model the underlying electoral process, failing to provide clear microfoundations for the government's objective function. Second, it would be relevant to consider the impact of lobbying by producer groups. Their pressure for lower pollution taxes could counteract the influence of environmental groups (when they lobby for higher pollution taxes) or reinforce it (when they lobby for lower pollution taxes). In both cases, unilateral environmental policies would become

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[31] GATT obligations are eroded by the fact that countries are able to invoke many exceptions to them. Examples are exceptions for health, welfare, and national security reasons (Articles XX and XXI), the General Waivers (Article XXV), or antidumping and countervailing duties (Articles VI).

[32] To some extent, environmental policy cooperation already happens within the E.U. and NAFTA (see Carraro e Siniscalco, 1993, and Bulmer-Thomas *et al.*, 1994).

less efficient compared to internationally coordinated policies. Finally, a model with symmetric countries does not capture the North-South divide which often characterizes international environmental relations. By relaxing the symmetry assumption, one could extend our analysis to consider the interaction between countries with different economic and political structures.

Appendix A

We introduce the following variables:

- I_{NE} (I^*_{NE}): indicator variable which is equal to one if the home (foreign) government is influenced by a national green lobby, and zero otherwise.
- I_{IE}: indicator variable which is equal to one if the governments are influenced by an international green lobby, and zero otherwise.

In Sections 2.3 and 2.4, we examine the policies that emerge when governments are influenced by national green lobbies which act non-cooperatively (i.e. $I_{NE} = I^*_{NE} = 1, I_{IE} = 0$). In Section 2.5, we derive the policy outcomes in the alternative case in which the two national lobbies coordinate their political efforts (i.e. $I_{NE} = I^*_{NE} = 0, I_{IE} = 1$).

We use the following expression to denote the effect of an increase in domestic import tariffs on international prices:

$$\frac{\partial \pi}{\partial \tau} = -\frac{M\prime}{M\prime + M^*\prime} \equiv -\phi. \tag{2.28}$$

Notice that ϕ always lies between 0 and 1.

Market clearing implies the following equilibrium conditions:

$$\frac{\partial M}{\partial t} = -\frac{\partial M^*}{\partial t} \Rightarrow D_q\delta - Y_p(\delta - 1) = (Y^*_p - D^*_q)\delta \tag{2.29}$$

$$\frac{\partial M}{\partial \tau} = -\frac{\partial M^*}{\partial \tau} \Rightarrow (D_q - Y_p)(1 - \phi) = -\phi(Y^*_p - D^*_q) \tag{2.30}$$

Unilateral Policies

When governments act non-cooperatively, policies are chosen so as to maximize (2.8). Under the assumption that lobbies offer truthful political contributions, the domestic (politically) optimal non-cooperative policies in a representative sector of the economy must satisfy:

$$a\frac{\partial W}{\partial t} + I_{NE}\frac{\partial W^{NE}}{\partial t} + I_{IE}\frac{\partial W^{IE}}{\partial t} = 0, \tag{2.31}$$

$$a\frac{\partial W}{\partial \tau} + I_{NE}\frac{\partial W^{NE}}{\partial \tau} + I_{IE}\frac{\partial W^{IE}}{\partial \tau} = 0, \tag{2.32}$$

while foreign unilateral policies must satisfy

$$a^*\frac{\partial W^*}{\partial t^*} + I^*_{NE}\frac{\partial W^{NE*}}{\partial t^*} + I_{IE}\frac{\partial W^{IE}}{\partial t^*} = 0, \tag{2.33}$$

$$a\frac{\partial W}{\partial \tau^*} + I^*_{NE}\frac{\partial W^{NE*}}{\partial \tau^*} + I_{IE}\frac{\partial W^{IE}}{\partial \tau^*} = 0. \tag{2.34}$$

Substituting partial derivatives into (2.31) and (2.32), we obtain:

$$\begin{aligned}
&a\Big\{Y(\delta-1) + tY_p(\delta-1) + Y + \tau\Big[D_q\delta - Y_p(\delta-1)\Big] - D\delta \\
&-H\Big[(1-\theta)\beta Y_p(\delta-1) + \theta\beta^* Y_p^*\delta\Big]\Big\} \\
&-I_{NE}s^E H\Big[(1-\theta)\beta Y_p(\delta-1) + \theta\beta^* Y_p^*\delta\Big] \\
&-I_{IE}\Big\{\beta Y_p(\delta-1)\Big[s^E H(1+\theta) + s^{E*}H^*\theta^*\Big] \\
&+\beta^* Y_p^*\delta\Big[s^{E*}H^*(1+\theta^*) + s^E H\theta\Big]\Big\} = 0,
\end{aligned} \tag{2.35}$$

and

$$\begin{aligned}
&a\Big\{Y(1-\phi) + \tau(1-\phi)(D_q - Y_p) + D - Y + tY_p(1-\phi) - D(1-\phi) \\
&-H\Big[(1-\theta)\beta Y_p(1-\phi) - \phi\theta\beta^* Y_p^*\Big]\Big\} \\
&-I_{NE}s^E H\Big[(1-\theta)\beta Y_p(1-\phi) - \theta\beta^* Y_p^*\phi\Big] \\
&-I_{IE}\Big\{\beta Y_p(1-\phi)\Big[s^E H(1+\theta) + s^{E*}H^*\theta^*\Big] \\
&-\beta^* Y_p^*\phi\Big[s^{E*}H^*(1+\theta^*) + s^E H\theta\Big]\Big\} = 0.
\end{aligned} \tag{2.36}$$

Foreign environmental and trade policies must satisfy two symmetric conditions.

The non-cooperative trade and environmental policy outcomes reported in Section 2.3 are obtained by solving equilibrium conditions (2.29)-(2.30) and (2.35)-(2.36) for the case of two symmetric countries.

Cooperative Policies

In the case of cooperation, environmental and trade policies are chosen so as to maximize equation (2.10). Under the assumption of truthfulness of the political contributions, this implies the following first-order conditions:

$$a^*\left[I_{NE}\frac{\partial W^{NE}}{\partial t}+I_{IE}\frac{\partial W^{IE}}{\partial t}\right]+aI^*_{NE}\frac{\partial W^{NE*}}{\partial t}+aa^*\left[\frac{\partial W}{\partial t}+\frac{\partial W^*}{\partial t}\right]=0, \tag{2.37}$$

$$a^*\left[I_{NE}\frac{\partial W^{NE}}{\partial \tau}+I_{IE}\frac{\partial W^{IE}}{\partial \tau}\right]+aI^*_{NE}\frac{\partial W^{NE*}}{\partial \tau}+aa^*\left[\frac{\partial W}{\partial \tau}+\frac{\partial W^*}{\partial \tau}\right]=0, \tag{2.38}$$

$$a\left[I^*_{NE}\frac{\partial W^{NE*}}{\partial t^*}+I_{IE}\frac{\partial W^{IE}}{\partial t^*}\right]+a^*I_{NE}\frac{\partial W^{NE}}{\partial t^*}+aa^*\left[\frac{\partial W}{\partial t^*}+\frac{\partial W^*}{\partial t^*}\right]=0, \tag{2.39}$$

$$a\left[I^*_{NE}\frac{\partial W^{NE*}}{\partial \tau^*}+I_{IE}\frac{\partial W^{IE}}{\partial \tau^*}\right]+a^*I_{NE}\frac{\partial W^{NE}}{\partial \tau^*}+aa^*\left[\frac{\partial W}{\partial \tau^*}+\frac{\partial W^*}{\partial \tau^*}\right]=0. \tag{2.40}$$

Substituting partial derivatives into (2.37) and (2.38), we obtain:

$$\begin{aligned}
&a^*\Big\{-I_{NE}s^E H\Big[(1-\theta)\beta Y_p(\delta-1)+\theta\beta^* Y_p^*\delta\Big]\\
&-I_{IE}\Big[\beta Y_p(\delta-1)\Big(s^E H(1+\theta)-s^{E*}H^*\theta^*\Big)-\beta^* Y_p^*\delta\Big(s^{E*}H^*(1+\theta^*)+s^E H\theta\Big)\Big]\Big\}\\
&+a\Big\{-I^*_{NE}s^{E*}H^*\Big[(1-\theta^*)\beta^* Y_p^*\delta+\theta^*\beta Y_p(\delta-1)\Big]\Big\}\\
&+aa^*\Big\{Y(\delta-1)+tY_p(\delta-1)+Y+\tau\Big[D_q\delta-Y_p(1-\delta)\Big]-D\delta\\
&-H\Big[(1-\theta)\beta Y_p(\delta-1)+\theta\beta^* Y_p^*\delta\Big]\\
&+Y^*\delta+t^*Y_p^*\delta+\tau^*\delta(D_q^*-Y_p^*)-D^*\delta\\
&-H^*\Big[(1-\theta^*)\beta^* Y_p^*\delta+\theta^*\beta Y_p(\delta-1)\Big]\Big\}=0,
\end{aligned} \tag{2.41}$$

$$
\begin{aligned}
&a^*\Big\{ - I_{NE}s^E H\Big[(1-\theta)\beta Y_p(1-\phi) - \theta\beta^* Y_p^*\phi\Big] \\
&-I_{IE}\Big[\beta Y_p(1-\phi)\Big(s^E H(1+\theta) + s^{E*}H^*\theta^*\Big) - \beta^* Y_p^*\phi\Big(s^{E*}H^*(1+\theta^*) + s^E H\theta\Big)\Big]\Big\} \\
&+a\Big\{ - I_{NE}^* s^{E*} H^*\Big[- (1-\theta^*)\beta^* Y_p^*\phi + \theta^*\beta Y_p(1-\phi)\Big]\Big\} \\
&+aa^*\Big\{Y(1-\phi) + \tau(1-\phi)(D_q - Y_p) + D - Y + tY_p(1-\phi) - D(1-\phi) \\
&\quad -H\Big[(1-\theta)\beta Y_p(1-\phi) - \theta\beta^* Y_p^*\phi\Big] \\
&\quad -Y^*\phi - \tau^*\phi(D_q^* - Y_p^*) - t^* Y_p^*\phi + D^*\phi \\
&\quad -H^*\Big[- (1-\theta^*)\beta^* Y_p^*\phi + \theta^*\beta Y_p(1-\phi)\Big]\Big\} = 0. \qquad (2.42)
\end{aligned}
$$

Two symmetric conditions must hold for the foreign country.

The cooperative trade and environmental policy outcomes reported in Section 2.3 are obtained by combining equilibrium conditions (2.29)-(2.30) and (2.41)-(2.42) for the case of two symmetric countries.

Free Trade Regime

In the case of a free trade regime, we set $\tau = \tau^* = 0$ and derive the unilateral and cooperative environmental policy outcomes reported in Section 2.4 by solving (2.29), (2.30), (2.35) and (2.41) for the case of two symmetric countries.

Chapter 3

Green and Producer Lobbies: Enemies or Allies?

3.1 Introduction

The purpose of the analysis carried out in this chapter is to understand how the presence of green and producer lobbies can affect the political determination of trade and environmental policies.

Recent events in the United States have illustrated the extent to which citizen groups condition trade and environmental policies, both at the national and multilateral level. On the trade side, the creation of the North American Free Trade Agreement (NAFTA) initially encountered the resistance of business, labor and environmental groups (VanGrasstek, 1992). By pledging in an environmental side agreement[1], the White House was able to win the support of at least some environmental groups and obtain the fast track authority to negotiate the trade agreement without a line-by-line veto from Congress.[2] More recently, environmental groups have joined forces with protectionist industries and labor groups to launch a fierce campaign against further trade liberalization, which has caused the breakdown

[1]The North American Agreement on Environmental Cooperation (NAAEC), could be characterized as being primarily concerned with safeguarding the sovereign rights of each party to establish its environmental standards while working towards the compatibility of standards.

[2]Opposition on the part of business and environmental groups has also undermined the project of a Free-Trade Area of the Americas (FTAA), which the United States, Canada and 34 American and Caribbean countries (all of them except Cuba) have agreed to establish by 2005.

of the new round of GATT/WTO negotiations in Seattle.[3] Industry and green lobbies have been extremely influential also on the environmental side. On some issues, such as multilateral emissions cuts, they have held different positions.[4] On others, such as the compliance of foreign legislation with American environmental standards, their objectives have often coincided. [5]

This chapter attempts to shed some light on the relationship between green and producer lobbies. In particular, we wish to address the following questions: when will their interests over trade and environmental polices be aligned and when will they diverge? What will be the unilateral and cooperative policies selected by politically minded governments? When will policy coordination be efficiency enhancing?

Understanding the nature of the relationship between lobby groups is important for two reasons. On the positive side, it can help us to explain observed trade and environmental policies. On the normative side, it can provide some guidance on how to construct efficient policy mechanisms in the presence of political distortions.

In Chapter 2, we have studied how green lobbying can influence the determination of trade and environmental policies when countries are large and emissions are transboundary. Here we extend the analysis to a situation in which both producer and environmental interests are organized.

To examine the relationship between interest groups and policy-makers, we adopt the common agency model pioneered by Bernheim and Winston (1986) and applied to trade policy by Grossman and Helpman (1994, 1995a,b). A national or supra-national government is the agent who sets trade and environmental policies. Green and producer lobbies act as principals and confront the government with contribution schedules, namely functions describing their political contributions

[3] See *The Economist*, December 11, 1999.

[4] While green lobbies have exercised "considerable influence on the negotiations" at the Kyoto Conference in favor of multilateral reductions in greenhouse emissions (*Financial Times*, December 11, 1997), a broad coalition of corporations, unions and economic lobby groups has organized "one of the most intensive campaigns ever mounted on a single political issue, seeking to convince that American curbs on greenhouse gas are unfair and damaging to the economy" (*Financial Times*, September 10 1997).

[5] For example, both lobbies have demanded compliance of foreign legislation with American environmental standards on incidental catching of dolphins set out in the Marine Mammal Protection Act.

contingent on the chosen economic policies. These can be interpreted, depending on the context, as legal campaign contributions, support demonstrations, or simply as bribes. The timing is that first lobbies simultaneously commit to contribution schedules, and then the government, having observed these schedules, sets trade and environmental policies. The implicit objective of incumbent politicians is to be re-elected. They trade off the political support that comes from heeding interest groups' demands against the alienation of voters that may result from the implementation of socially costly policies.

A key feature of our model is that the countries considered are large, i.e. they are able to affect world prices. This implies that a unilateral increase in domestic pollution taxes or decrease in import tariffs generate *pollution leakages*, i.e. they shift the terms of trade away from the implementing country, leading to an increase in emissions by its trading partners. If emissions cross borders, the increase in foreign pollution will have a negative environmental impact from the point of view of the domestic residents.

Focusing on the case of two symmetric countries, we examine the impact of green and producer lobbying on the unilateral and cooperative policy outcomes obtained in three alternative regimes: one where governments control both trade and environmental policies; one in which they are restrained to the use of environmental policy by an existing free trade agreement; and one in which trade policy is the only available instrument.

We show that, in the presence of emission spillovers and pollution leakages, the relationship between green and producer interests over trade and environmental policy is ambiguous. If instead pollution is local and/or the pollution leakages are eliminated either through the combined use of trade and environmental policy instruments or through international policy cooperation, green and producer lobbies will unambiguously be enemies or allies.

The analysis presented in this chapter is part of a vast literature which looks at the relationship between interest groups and policy-makers.[6] Most studies have focused on the role of producer groups in the determination of *trade policy*.[7] In this area, the *political contributions* approach of Grossman and Helpman (1994,

[6]See Persson and Tabellini (2000), for an extensive review of this literature.

[7]The literature on the political economy of trade policy is nicely reviewed by Rodrik (1995).

1995a,b) adopted in this paper has become something of a work-horse model (see Cadot *et al* (1997), Rama and Tabellini (1998) and Mitra (1999), among many others).[8] A similar approach, originally developed by Stigler (1971) and Peltzman (1976), and first applied to trade policy by Hillman (1982), describes trade policy as being set by an incumbent government seeking to maximize its *political support*. A third approach, developed by Magee *at al.* (1989), and Hillman and Ursprung (1988), focuses on the *electoral competition* among political parties. Here lobbies do not directly affect policy choices, but instead influence the probability of their favorite party being elected. Alternatively, Austen- Smith (1997) views the policy-making process as being characterized by uncertainty. In his framework, interest groups influence the provision of informational expertise. Most studies on the political economy of trade policy have disregarded the environmental impact of trade and the role of green lobbies. Two notable exceptions in this respect are Hillman and Ursprung (1992, 1994), who introduce environmental lobby groups in a model of endogenous trade policy.

A more recent body of literature, which includes Fredriksson (1997) and Aidt (1998), has studied the political economy of *environmental policy*. These studies adopt the political contribution approach to study the impact of green and producer interest on environmental policy, but differ from our analysis in a number of ways. First, they only study environmental policy, while we are interested in the *joint* determination of trade and environmental policies. Second, they focus on local environmental problems in a small open economy, while we look at trans-boundary environmental problems between large countries. Third, in their setup, the interests of green and producer lobbies over environmental policy are always divergent, while we show that in some cases they might actually coincide. This consideration has also efficiency implications: while they find that the competition between green and producer lobbies is the "driving force behind the political internalization of externalities" (Aidt, 1998, p. 13), we show that a possible alliance between them can exacerbate the environmental distortion.

[8] Gawande and Bandyopadhyay (2000) have recently tested the empirical predictions of Grossman and Helpman (1994)'s model about the pattern of protection and lobbying spending. Using cross-industry data on US nontariff barriers and US lobby spending, they find that US pattern of protection is indeed "influenced by lobbying spending and lobbying competition, and that, hence, protection is sold".

The issue of the link between the trade policy regime and stringency of environmental regulations has been recognized in number of papers. A study by Perroni and Wigle (1994) shows that, given the level of environmental regulations, trade policy has little impact on the quality of the environment. Husted and Logsdon (1997) find instead that the NAFTA agreement has lead Mexico to strengthen its environmental policies.[9] On the theoretical side, Fredriksson (1999) examines a scenario in which environmental and industry interest lobby groups influence the determination of pollution taxes in sectors protected by tariffs. The level of protectionism is exogenously determined.[10] The main result of his analysis is that the level of political conflict on environmental policy falls with trade liberalization. Schleigh (1999) studies the joint determination of trade and environmental policies. The government is assumed to have a single or a variety of domestic and trade policy instruments to address production or consumption externalities and to obtain political contributions from producer lobby groups. He shows that, in the presence of both trade and environmental distortions, inefficient trade policies can lead to higher environmental quality than more efficient domestic policies. Differently from our analysis, both Fredriksson (1999) and Schleigh (1999) focus on a small economy and on local environmental problems, thus leaving aside the leakage effects of trade and environmental policies.

The remainder of the chapter is organized as follows. In Section 3.2, we describe the economic and political features of the model. In Section 3.3, we derive unilateral and cooperative equilibrium policies in alternative regimes. Section 3.4 analyzes the relationship between green and producer interests. Section 3.5 discusses the relative efficiency of the policy outcomes. Finally, Section 3.6 presents some concluding remarks.

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[9]For example, regulatory plant inspections have increased from 1425 in 1990 to 13,993 in 1995.

[10]Fredrikkson (1999) compares an initial scenario with exogenously given tariffs with a free trade scenario. As noted by the author, this analysis only applies to small open economies with a negligible impact on multilateral trade talks.

3.2 The Model

3.2.1 The Economy

We consider two large countries, denominated home (no *) and foreign (*). Our analysis is mainly focused on the economic and political structure of the home country (the foreign country will have symmetric characteristics).

The economy is described by a Ricardo-Viner model in which there are $N+1$ goods $i = 0, 1, \ldots, N$. All goods are produced under constant returns to scale and sold in a competitive market. Production of the numeraire good 0 requires labor alone and does not generate pollution. Production of all other goods requires both the mobile factor, labor, and a sector specific capital, and generates emissions at the fixed level β per unit of output.

The numeraire good is traded freely across countries, with a world and a domestic price equal to one. In a competitive equilibrium, this implies that wage rate is also equal to unity.[11]

Let π_i be the international price of a non-numeraire good and q_i and p_i be its domestic consumer and producer prices, respectively. The reward to the owners of a specific factor can be denoted as $\Pi_i(p_i)$. By Hotelling's Lemma, the industry supply curve is then equal to $Y_i(p_i) = \partial\Pi_i/\partial p_i$, where $\partial Y_i/\partial p_i > 0$, and $\partial Y_i/\partial p_i^2 \leq 0$.

The economy is populated by H individuals, $h = 0, 1, \ldots, H$, with identical preferences. Utility is quasilinear and additively separable:

$$u_h(c_0, \ldots, c_N, Z) \equiv c_0 + \sum_{i=1}^{N} u_i(c_i) - Z, \tag{3.1}$$

where c_0 and c_i indicate consumption of the numeraire and non-numeraire goods. The functions $u(c_i)$ are differentiable, increasing, and strictly concave. The last term captures the disutility caused by environmental damage:

$$Z(\mathbf{p}, \mathbf{p}^*) \equiv \sum_{i=1}^{N} \Big[(1-\theta_i)\beta_i Y_i(p_i) + \theta_i \beta_i^* Y_i^*(p_i^*)\Big], \tag{3.2}$$

[11] The economy's labor supply is assumed to be sufficiently large for the supply of the numeraire good to be positive.

where $\mathbf{p}$ and $\mathbf{p}^*$ are vectors of producer prices and $(1-\theta_i)$ and θ_i are the relative weights associated with domestic and foreign emissions in sector i, respectively. Equation (3.2) implies that, if the coefficient θ_i is positive, citizens in the home country are negatively affected by the emissions generated in both the domestic and foreign production of good i. The larger is θ_i, the larger is the impact of foreign pollution on the environmental damage suffered by the home citizens.

Inverse demand for a non-numeraire good can be expressed as a function of its price alone, i.e. $D_i(q_i)$. The indirect utility function corresponding to (3.1) can be written as:

$$\begin{aligned} V_h(\mathbf{q},\mathbf{p},\mathbf{p}^*) \quad &\equiv L_h + \sum_{i=1}^{N} \lambda_i^h \Pi_i(p_i) + \frac{1}{H}\sum_{i=1}^{N} t_i Y_i(p_i) + \frac{1}{H}\sum_{i=1}^{N} \tau_i \Big[D_i(q_i) - Y_i(p_i)\Big] \\ &+ \sum_{i=1}^{N} u\Big(D_i(q_i)\Big) - \sum_{i=1}^{N} q_i D_i(q_i) - Z(\mathbf{p},\mathbf{p}^*). \end{aligned} \tag{3.3}$$

The terms in the first row of (3.3) represent income, which consists of wage income (L_h), capital claims (with λ_h indicating the share of capital owned by individual h)[12] and $1/H$ of environmental and trade revenues, transferred as a lump sum. The first two terms in the second row capture consumer surplus and the last term indicates environmental damage.

We consider two policy instruments: environmental taxes/subsidies $\mathbf{t}$ and import tariffs/subsidies $\boldsymbol{\tau}$. Thus the consumer prices of a non-numeraire good is given by $q_i = \pi_i + \tau_i$ and its producer price is $p_i = \pi_i + \tau_i - t_i$.

International product markets clear when

$$M_i(\pi_i,\tau_i,t_i) + M_i^*(\pi_i,\tau_i^*,t_i^*) = 0, \qquad \forall i = 1,\ldots,N, \tag{3.4}$$

where $M_i = D_i(q_i) - Y_i(p_i)$ and $M_i^* = D_i^*(q_i)^* - Y_i^*(p_i)^*$ represent the net imports of the home and foreign countries.

3.2.2 The Leakage Effects of Trade and Environmental Policies

In the setup described above, both countries are "large" in that they are able to affect world prices. In such a scenario, a unilateral increase in pollution taxes or a

[12] We assume that individuals own at most one type of specific factor.

unilateral tariff cut will raise world prices and hence lead to an increase in foreign emissions. The indirect effects of domestic policies on foreign emissions via trade are referred to in the literature as *pollution leakages* (Copeland and Taylor, 2000).

Formally, an increase in the domestic pollution tax on good i[13] generates the following effect on its international price:

$$\frac{\partial \pi}{\partial t} = -\frac{Y_p}{M\prime + M^{*}\prime} \equiv \delta, \tag{3.5}$$

where $M\prime = D_q - Y_p$, with $Y_p = \partial Y/\partial p$ and $D_q = \partial D/\partial q$. Notice that δ always lies between 0 and 1, implying an increase in the international price. Therefore, a unilateral increase in domestic pollution taxes shifts the comparative advantage of producing 'dirty' goods in favor of the foreign country and generates the following leakage effect:

$$\frac{\partial E^{*}}{\partial t} = \beta^{*} Y_p^{*} \delta. \tag{3.6}$$

Hence, if pollution taxes are raised unilaterally and unaccompanied by the use of import tariffs, they can only reduce domestic pollution at the cost of increased foreign pollution. It is important to stress that what is leaking through trade is not domestic pollution but domestic environmental policy. Thus, a leakage could also arise if environmental problems are strictly local. However, it is only in the case of transboundary environmental problems ($\theta_i > 0$) that the leakage negatively affects domestic residents. In this case, the environmental impact of an increase in the domestic pollution tax from the point of view of domestic residents is

$$\frac{\partial Z}{\partial t} = (1-\theta)\beta Y_p(\delta - 1) + \theta\beta^{*} Y_P^{*}\delta; \tag{3.7}$$

hence in the presence of trade flows higher domestic pollution taxes have two opposite environmental effects: a *direct positive effect*, due to a reduction in domestic emissions by $(1-\theta)\beta Y_p(\delta - 1)$; and an *indirect negative effect*, due to an increase in foreign transboundary emissions by $\theta\beta^{*} Y_p^{*}\delta$. The relative importance of the negative environmental effect increases with the size of the pollution leakages and the degree to which foreign emissions cross over into the home country. Therefore,

[13] Given the quasilinearity of the utility function, there is no possibility of substitution among goods such that the amount of pollution resulting from a given level of production can be varied. This allows us to study the determination trade and environmental policies in a representative non-numeraire sector i of the economy. For ease of the exposition, in what follows we drop the sectoral subscript.

Proposition 1 *A unilateral increase in pollution taxes, if unaccompanied by an increase in import tariffs, can lead to environmental degradation. A sufficient condition for this to occur is that the indirect environmental costs associated with the increase in transboundary foreign emissions outweigh the direct environmental benefits due to the reduction in domestic emissions.*

Consider now the impact of a unilateral increase in domestic import tariffs on the international price:

$$\frac{\partial \pi}{\partial \tau} = -\frac{M\prime}{M\prime + M^{*}\prime} \equiv -\phi. \tag{3.8}$$

Since $0 < \phi < 1$, higher domestic tariffs imply a fall in the international price and a shift of the terms of trade in favor of the implementing country. This generates the following leakage effects:

$$\frac{\partial E^{*}}{\partial \tau} = -\beta^{*} Y_{p}^{*} \phi. \tag{3.9}$$

The overall environmental impact of the domestic tariff increase is

$$\frac{\partial Z}{\partial \tau} = (1-\theta)\beta Y_{p}(1-\phi) - \theta \beta^{*} Y_{p}^{*} \phi. \tag{3.10}$$

Therefore, in the presence of trade flows higher domestic pollution taxes have two opposite environmental effects: a *positive effect*, due to a reduction in transboundary foreign emissions by $-\theta\beta^{*}Y_{p}^{*}\phi$; and a *negative effect*, due to an increase in domestic emissions by $(1-\theta)\beta Y_{p}(1-\phi)$. The relative importance of the negative environmental effect decreases with the size of the pollution leakages and the degree to which foreign emissions cross over into the home country. The following result follows immediately from (3.10):

Proposition 2 *A unilateral increase in import tariffs, if unaccompanied by an increase in pollution taxes, can lead to environmental degradation. A sufficient condition for this to occur is that the environmental costs associated with the increase in domestic emissions outweigh the environmental benefits due to the reduction in transboundary foreign emissions.*

To summarize the results obtained in this Section, when emission taxes and import tariffs are selected unilaterally and are not combined, they can only reduce pollution in one country at the cost of increased pollution in the other country.

Propositions 1 and 2 will be key in understanding the relationship between green and producer lobbies. In Section 3.4, we will show that, in the presence of pollution leakages such relationship will be ambiguous; if, however, the leakages effects of domestic policies are eliminated either through the combined use of pollution taxes and import tariffs or through international policy coordination, the relationship between the two lobbies will be unambiguous.

3.2.3 The Political Process

Our model does not explain the process of lobby formation. We simply assume that only the following groups of citizens can overcome the free-riding problem described by Olson (1965) and get politically organized: a proportion s^E of the population, the 'environmentalists', who form a national green lobby; and the owners of a subset S of all specific factors, who form producer lobbies in their respective sectors. In each sector $i \in S$, capital owners represent a proportion s^P of the population.

Political competition can be modelled as a two-stage game. In the first stage, green and producer lobbies simultaneously present incumbent policymakers with contribution schedules, namely functions mapping every combination or trade and environmental policy into a level of political contribution. We assume that a citizen cannot be a member of more than one interest group. We also exclude the possibility that lobbies cooperate with one another and that they can offer political contributions to politicians in the other country. Therefore, when we refer to an 'alliance' between green and producer lobbies, we will be alluding to the fact that they exercise political pressure in the same direction, without formally coordinating their actions. The equilibrium set of contribution schedules is one in which each lobby maximizes the aggregate utility of its members, given the schedules of the other lobby group.

In the second stage, incumbent politicians select trade and environmental policies, given the equilibrium contribution schedules, and collect the corresponding contributions from every lobby. They are concerned with aggregate well-being, but also with the support they get from interest groups. In equilibrium, the decision-makers balance optimally the marginal benefit of net aggregate contributions against the marginal welfare cost of distortionary trade and environmental

policies.

In contrast to Grossman and Helpman (1994), we assume that interest groups are 'functionally specialized' (Aidt, 1998), in the sense that producer lobbies are only concerned about industry profits and the green lobby is only concerned about environmental damage.[14] The gross (of contributions) welfare of a producer lobby $i \in S$ is thus given by:

$$W_i^P(t_i, \tau_i, t_i^*, \tau_i^*) \equiv s^P H \Pi_i(t_i, \tau_i, t_i^*, \tau_i^*), \qquad \forall i \in S, \tag{3.11}$$

while the utility of the national environmental lobby is

$$W^E(\mathbf{t}, \boldsymbol{\tau}, \mathbf{t}^*, \boldsymbol{\tau}^*) \equiv B - s^E H Z(\mathbf{t}, \boldsymbol{\tau}, \mathbf{t}^*, \boldsymbol{\tau}^*), \tag{3.12}$$

where B is a constant.

National producer and green lobbies present their government with contribution schedules $C_i(\mathbf{t}, \boldsymbol{\tau}; \mathbf{t}^*, \boldsymbol{\tau}^*)$. Their objective functions are, respectively,

$$\tilde{W}_i^P(\mathbf{t}, \boldsymbol{\tau}, \mathbf{t}^*, \boldsymbol{\tau}^*) \equiv W_i^P(t_i, \tau_i, t_i^*, \tau_i^*) - C_i(t_i, \tau_i; t_i^*, \tau_i^*), \qquad \forall i \in S, \tag{3.13}$$

and

$$\tilde{W}^E(\mathbf{t}, \boldsymbol{\tau}, \mathbf{t}^*, \boldsymbol{\tau}^*) \equiv W^E(\mathbf{t}, \boldsymbol{\tau}, \mathbf{t}^*, \boldsymbol{\tau}^*) - \sum_i C_i(t_i, \tau_i; t_i^*, \tau_i^*). \tag{3.14}$$

The implicit objective of incumbent politicians is to be reelected.[15] This implies that they care about the utility level achieved by the median voter, particularly if voters are well informed about the effects of government policy and base their vote partly on their standard of living. Incumbent politicians also value political contributions for financing future campaigns and deterring competitors. The government's objective is thus given by

$$G(\mathbf{t}, \boldsymbol{\tau}, \mathbf{t}^*, \boldsymbol{\tau}^*) \equiv aW(\mathbf{t}, \boldsymbol{\tau}, \mathbf{t}^*, \boldsymbol{\tau}^*) + \sum_i C_i(t_i, \tau_i; t_i^*, \tau_i^*), \qquad a \geq 0, \tag{3.15}$$

where W is the welfare of citizens (or "social welfare") and a represents the weight that the government attaches to social welfare relative to lobbies' contributions.

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[14] The motivation for focusing on functionally specialized lobby groups is empirical: while it is possible to find examples of lobby groups with multiple goals, most interest groups are highly specialized (see Marshall, 1998).

[15] See Grossman and Helpman (1996) for an explicit treatment of the electoral stage.

Social welfare is defined as aggregate income plus total consumer surplus minus total environmental damage:

$$W(\mathbf{t},\boldsymbol{\tau},\mathbf{t}^*,\boldsymbol{\tau}^*) \equiv L+\sum_{i=1}^{N}\Pi_i(t_i,\tau_i,t_i^*,\tau_i^*)+\sum_{i=1}^{N}t_iY_i(t_i,\tau_i,t_i^*,\tau_i^*)+\sum_{i=1}^{N}\tau_iM_i(t_i,\tau_i,t_i^*,\tau_i^*)$$
$$+H\Big[\sum_{i=1}^{N}u\Big(D_i(t_i,\tau_i,t_i^*,\tau_i^*)\Big)-\sum_{i=1}^{N}q_iD_i(t_i,\tau_i,t_i^*,\tau_i^*)\Big]-HZ(\mathbf{t},\boldsymbol{\tau},\mathbf{t}^*,\boldsymbol{\tau}^*). \tag{3.16}$$

In order to derive the equilibrium cooperative policies, we can rely on the notion that the outcomes of international negotiations must satisfy Pareto efficiency for the two policy-makers involved (see Grossman and Helpman, 1995a). This implies that cooperative policies must maximize the weighted sum

$$G^W \equiv a^*G+aG^* = a^*a\Big[W(\mathbf{t},\boldsymbol{\tau},\mathbf{t}^*,\boldsymbol{\tau}^*)+W^*(\mathbf{t}^*,\boldsymbol{\tau}^*,\mathbf{t},\boldsymbol{\tau})\Big]+$$
$$a^*\sum_i C_i(t_i,\tau_i,t_i^*,\tau_i^*)+a\sum_i C_i^*(t_i^*,\tau_i^*,t_i,\tau_i). \tag{3.17}$$

Thus the cooperative equilibrium policies are the same that would be selected by a single decision (a "supra-national mediator") with preferences as given on the right hand side of (3.17).[16]

Common agency games of the types described typically admit a multiplicity of Nash equilibria. Following Grossman and Helpman (1994), we focus on *truthful equilibria*, where lobbies make contributions up to the point where the resulting change in economic policies is exactly offset by the marginal cost of the contributions.[17]

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[16]Notice that (3.17) stipulates that cooperative policies must be efficient for the two governments without specifying how the surplus will be divided between them. To determine which utility pair (G, G^*) will be selected, a bargaining procedure should be introduced. One could adopt the Nash bargaining solution or, as in Grossman and Helpman (1995a), the Rubinstein's bargaining solution.

[17]It can be shown that only truthful contributions support coalition-proof Nash equilibria, and vice-versa, all such equilibria are reflected by truthful contributions (see Bernheim and Whinston, 1986).

3.3 The Policy Equilibria

In this section, we characterize the (politically) optimal unilateral and cooperative equilibrium policies in a sector $i \in S$ of the economy.[18] We focus on the simple case in which the two countries have identical economic and political structures and consider three alternative policy regimes: one where governments have control over both trade and environmental policies; one in which they are restrained to the use of environmental policy by an existing free trade agreement; and one in which trade policy is the only instrument at their disposal.

3.3.1 Trade and Environmental Outcomes

Let us first consider the case where governments set trade and environmental taxes independently. Using the equilibrium conditions given in Appendix B, we obtain:

$$\tau_{NC} = \tau^*_{NC} = \frac{\beta H \theta Y_p (a + s^E)}{a(Y_p - D_q)}, \tag{3.18}$$

and

$$t_{NC} = t^*_{NC} = \frac{H[\beta Y_p (a + s^E)(1 - \theta) - s^P Y]}{a Y_p}. \tag{3.19}$$

In the case of centralized decision-making, governments select the following policies:

$$\tau_C = \tau^*_C = 0, \tag{3.20}$$

and

$$t_C = t^*_C = \frac{H[\beta Y_p (a + s^E) - s^P Y]}{a Y_p}. \tag{3.21}$$

3.3.2 Environmental-only Outcomes

Next, consider the case in which the two governments have signed a free trade agreement, eliminating the tariffs on each other's imports. In this scenario, environmental policy is the only instrument available. Unilateral emissions are given

[18] The equilibrium conditions for unilateral and cooperative trade and environmental policies are given in Appendix B.

by

$$t_{NC} = t^*_{NC} = \frac{H[\beta Y_p(a + s^E)(\delta + \theta - 1) - s^P Y(\delta - 1)]}{aY_p(\delta - 1)}, \tag{3.22}$$

while international policy coordination yields

$$t_C = t^*_C = \frac{H[\beta Y_p(a + s^E) - s^P Y]}{aY_p}. \tag{3.23}$$

3.3.3 Trade-only Outcomes

Finally, suppose trade policy is the only instrument available. Unilateral policy-making leads to the adoption of the following import tariffs:

$$\tau_{NC} = \tau^*_{NC} = \frac{H[\beta Y_p(a + s^E)(1 - 2\theta) - s^P Y]}{a(D_q - Y_p)}, \tag{3.24}$$

while cooperative policy-making results in the adoption of identical import tariffs:

$$\tau_C = \tau^*_C. \tag{3.25}$$

3.4 Green and Producer Lobbies: Competition or Alliance?

In this section, we examine the impact of lobbying by green and producer groups on the policy outcomes derived above. This then allows us to evaluate whether green and producer lobbies have similar or divergent interests over trade and environmental policy. As a measure of a lobby's influence, we consider the effect of a change in its size on the policy outcomes, i.e. $\partial\tau/\partial s^E$ and $\partial t/\partial s^E$ for the green lobbies and $\partial\boldsymbol{\tau}/\partial s^P$ and $\partial\mathbf{t}/\partial s^P$ for producer lobbies.[19]

Let us examine each of the policy scenarios considered in the previous section, starting from the case in which governments can use both policy instruments and act in a non-cooperative manner. We obtain the following result:

[19]Notice that defining political pressure in terms of lobby's contributions for each single policy vector would be inappropriate, since it would not take into account the interdependence between trade and environmental policies.

Lemma 3.1 *If two symmetric governments select trade and environmental policies unilaterally, green and producer lobbies will have opposite interests over environmental policy.*

PROOF: Green lobbying leads to an increase in the pollution tax by

$$\frac{\partial t_{NC}}{\partial s^E} = \frac{\beta H(1-\theta)}{a} > 0, \tag{3.26}$$

and to an increase in the import tariff by

$$\frac{\partial \tau_{NC}}{\partial s^E} = \frac{\beta H \theta Y_p}{a(Y_p - D_q)} > 0. \tag{3.27}$$

Producer lobbying leads to a fall in the pollution tax by

$$\frac{\partial t_{NC}}{\partial s^P} = -\frac{HY}{aY_p} < 0, \tag{3.28}$$

and has no effect on equilibrium import tariffs:

$$\frac{\partial \tau_{NC}}{\partial s^P} = 0. \tag{3.29}$$

Q.E.D.

Moving to the case of centralized decision-making, we find:

Lemma 3.2 *If two symmetric governments select trade and environmental policies cooperatively, green and producer lobbies will have opposite interests over environmental policy.*

PROOF: The presence of the green lobby implies an increase in cooperative pollution taxes:

$$\frac{\partial t_C}{\partial s^E} = \frac{\beta H}{a} > 0. \tag{3.30}$$

The impact of producer lobbying on the cooperative equilibrium policies is:

$$\frac{\partial t_C}{\partial s^P} = -\frac{HY}{aY_p} < 0. \tag{3.31}$$

None of the lobbies has any impact on the trade policy outcomes:

$$\frac{\partial \tau_C}{\partial s^E} = \frac{\partial \tau_C}{\partial s^P} = 0. \tag{3.32}$$

Q.E.D.

Consider now the situation in which governments have committed to free trade. In the case of decentralized decision-making, we obtain the following result:

Lemma 3.3 *If two symmetric governments select emission taxes non-cooperatively, the interests green and producer lobbies will have opposite interests over environmental policy if and only if* $\delta + \theta < 1$.

PROOF: Under a free trade regime, green lobbying has an ambiguous effect on the non-cooperative environmental outcomes:

$$\frac{\partial t_{NC}}{\partial s^E} = \frac{\beta H(\delta + \theta - 1)}{a(\delta - 1)}. \tag{3.33}$$

It is straightforward to verify that expression (3.33) is positive for $\delta + \theta < 1$. This condition implies green lobbies will support a unilateral increase in pollution taxes only if the environmental benefits associated with the decrease in domestic pollution outweigh the environmental costs due to the increase in foreign transboundary pollution. The impact of producer lobbying on the unilateral environmental policy outcomes is

$$\frac{\partial t_{NC}}{\partial s^P} = -\frac{HY}{aY_p} < 0. \tag{3.34}$$

Q.E.D.

If the decision-making process is centralized, the relationship between environmental and producer groups is described by the following lemma:

Lemma 3.4 *If two symmetric governments select emission taxes cooperatively, green and producer lobbies will always have opposite interests over environmental policy.*

PROOF: Green lobbying biases cooperative emission taxes upwards:

$$\frac{\partial t_C}{\partial s^E} = \frac{\beta H}{a} > 0, \tag{3.35}$$

while producer lobbying has the opposite effect:

$$\frac{\partial t_C}{\partial s^P} = -\frac{HY}{aY_p} < 0. \tag{3.36}$$

The competitive nature of the relationship between the two lobbies is due to the fact that a multilateral increase in emission taxes will unambiguously lead to a reduction in productive activities in both countries, which implies a reduction in

total environmental damage and a fall in industry profits in both countries. Q.E.D.

Let us now consider the scenario in which trade policy is the only instrument available. When import tariffs are selected in an independent manner, we obtain:

Lemma 3.5 *If two symmetric governments select import tariffs unilaterally, green and producer lobbies will have opposite interests if and only if* $\theta < 1/2$.

PROOF: An increase in the size of the green lobby has the following impact on non-cooperative import tariffs:

$$\frac{\partial \tau_{NC}}{\partial s^E} = \frac{\beta H Y_p (1-2\theta)}{a(D_q - Y_p)}, \tag{3.37}$$

which is negative for $\theta < 1/2$. This implies that in the case of local or regional environmental problems ($\theta \leq 1/2$) green lobbying will bias import tariffs downwards, since in this case the environmental costs associated with the increase in domestic emissions will outweigh the environmental benefits due to the fall in foreign emissions; in the case of global environmental problems ($\theta = 1/2$), green lobbying will have no effect on the trade policy outcomes, since the environmental gains associated with the decrease in foreign pollution will exactly offset the costs associated with the increase in domestic emissions. The impact of producer lobbying is:

$$\frac{\partial \tau_{NC}}{\partial s^P} = \frac{HY}{a(Y_p - D_p)} > 0. \tag{3.38}$$

Q.E.D.

Finally, Lemma 3.6 applies to the case of trade policy coordination:

Lemma 3.6 *If two symmetric governments select import tariffs cooperatively, green and producer lobbies have no impact on the policy outcomes.*

PROOF: an increase in the side of the green or producer lobby has no effect on the cooperative equilibrium tariffs:

$$\frac{\partial \tau_C}{\partial s^E} = \frac{\partial \tau_C}{\partial s^P} = 0. \tag{3.39}$$

This result is due to the fact that in equilibrium two symmetric countries will always adopt identical import tariffs and trade policy will thus have no impact on productive activities and emission levels. Q.E.D.

The results presented in Lemmas 3.1-3.6 are summarized by Table 3.1 and by the following Proposition:

Proposition 3.1 *The nature of the relationship between green and producer lobbies depends crucially on which policy instruments are available, whether government act in a unilateral or cooperative manner, and the magnitude of the emission leakages and the associated transboundary spillovers.*

Table 3.1 shows that the ambiguity of the relationship between green and producer groups arises only in the presence of pollution leakages and emission spillovers (cases 3 and 5). If instead pollution is local and/or pollution leakages are eliminated either through the combined use of trade and environmental policy (cases 1 and 2) or through international policy coordination (cases 2, 4, and 6), the relationship between green and producer groups is always unambiguous.

3.5 The Efficiency Question

The model presented in this chapter is characterized by the existence of three types of distortions: an environmental distortion, caused by the presence of emission spillovers; a trade distortion, due to the fact that countries are able to affect the terms of trade; and a political distortion, arising from the lobbying activities of green and producer groups. The question we want to address in this section is the following: is it still possible to achieve efficient policy outcomes in this second-best world?

The first-best solution—which is obtained when benevolent policymakers act cooperatively—requires that governments eliminate tariffs on each other's imports and adopt optimal Pigouvian emission taxes, which reflects the social marginal damage of emissions:

$$\tau = \tau^* = 0, \tag{3.40}$$

Table 3.1: The Relationships between Green and Producer Lobbies

Policy Regimes	Policy-making Process	
	Decentralized	Centralized
Trade and Environment	1 Competition over environmental Policy	2 Competition over environmental Policy
Environment only	3 Competition over environmental policy if $\delta + \theta < 1$	4 Competition over environmental Policy
Trade only	5 Competition over trade policy if $\theta < 1/2$	6 —

$$t_P = t_P^* = \beta H. \tag{3.41}$$

Due to the symmetry assumption, the two countries always select identical tariffs. As noted above, this implies that in equilibrium there is no trade distortion. In this setup, it is thus possible to focus the analysis on the relative efficiency of alternative environmental policy outcomes, which we simply measure scenarios in terms of their distance from (3.41). We obtain to the following result:

Proposition 3.2 *In the case of symmetric countries, the first-best solution can only be achieved if and only: (i) pollution taxes are an available policy instrument; (ii) green and producer lobbies have opposite interests over environmental policy;*

and (iii) green lobbies have size $\hat{s^E}$.

PROOF: Table 3.2 reports the size of the green lobby for which the environmental policy outcomes given in Section 3.3 are equal to the optimal Pigouvian taxes. Notice that *efficiency can only be achieved though the use of emission taxes.* In the policy regime in which import tariffs are the only available instrument, the environmental distortion cannot be corrected. The reason behind this result is that, due to the symmetry assumption, trade policy has no effect on relative prices and productive activities.

Table 3.2 also reveals that the *relative efficiency of the policy outcomes depends on the nature of the relationship between the two lobbies*: if governments act unilaterally and are bound by a free trade agreement, $\hat{s}$ is positive if and only if $\theta + \delta < 1$. This implies that efficiency can only be achieved if the green and producer lobbies are in competition. Q.E.D.

Comparing the unilateral and cooperative policy-making processes, we obtain the following result:

Lemma 3.7 *The size of the green lobby necessary to reach efficiency at the supra-national decision-making level is smaller than at the national level.*

PROOF: Consider first the regime where both trade and environmental policies are available. The difference between the critical size of green lobbies in the case of a unilateral decision-making and in the case of policy cooperation is:

$$\frac{s^P \theta Y + \beta a \theta Y_p}{\beta Y_p (1 - \theta)} > 0. \tag{3.42}$$

The corresponding expression for the regime in which environmental policy is the only available instrument is

$$\frac{\theta(s^P Y + \beta a Y_p)}{\beta Y_p (1 - \delta - \theta)} > 0. \tag{3.43}$$

Q.E.D.

The intuition behind Lemma 3.7 is simple. Cooperative pollution taxes are efficient in the absence of lobbies; in the presence of green and producer lobbies,

Table 3.2: Efficiency and the Size of the Green Lobby

Policy Regimes	Policy-making Process	
	Decentralized	Centralized
Trade and Environment	$\hat{s^E} = \frac{s^P Y + \beta H a \theta Y_p}{\beta Y_p (1-\theta)}$	$\hat{s^E} = \frac{s^P Y}{\beta Y_p}$
Environment only	$\hat{s^E} = \frac{s^P Y (1-\delta) + \beta a \theta Y_p}{\beta Y_p (1-\delta-\theta)}$	$\hat{s^E} = \frac{Y}{\beta H Y_p}$
Trade only	—	—

they can be efficient if green lobbies are large enough to exactly offset the political pressure exercised by producer lobbies. For unilateral environmental policies to be efficient, however, green lobbies must be larger, so that their bias towards higher taxes counteracts the downward bias of both producer groups and national governments.

3.6 Concluding Remarks

In this chapter we have employed a common agency model to examine the role of green and producer lobbies in the joint determination of trade and environmental policy. We have focused our analysis on the case of two large symmetric countries,

which are linked through trade and transboundary pollution.

We have characterized the policy outcomes and the relationship between lobbies in three alternative policy regimes: one where governments control both trade and environmental policies; one in which they are restrained to the use of environmental policy by an existing free trade agreement; and one in which trade policy is the only available instrument.

We have shown that, in the presence of emission spillovers and pollution leakages, the relationship between green and producer interests over trade and environmental policy is ambiguous. If instead pollution is local and/or the pollution leakages are eliminated either through the combined use of trade and environmental policy instruments or through international policy cooperation, green and producer lobbies will unambiguously be enemies or allies.

Appendix B

We introduce the following indicator variables:

- I_E (I_E^*): indicator variable which is equal to one if the home (foreign) government is influenced by a national green lobby, and zero otherwise.
- I_P (I_P^*): indicator variable which is equal to one if there is an organized producer lobby in the home (foreign) country, and zero otherwise.

Market clearing implies the following equilibrium conditions:

$$\frac{\partial M}{\partial t} = -\frac{\partial M^*}{\partial t} \Rightarrow D_q\delta - Y_p(\delta - 1) = (Y_p^* - D_q^*)\delta \tag{3.44}$$

$$\frac{\partial M}{\partial \tau} = -\frac{\partial M^*}{\partial \tau} \Rightarrow (D_q - Y_p)(1 - \phi) = -\phi(Y_p^* - D_q^*) \tag{3.45}$$

Unilateral Policies

In the case of non-cooperation, trade and environmental policies are selected to maximize (3.15). Under the assumption that lobbies offer truthful political contributions, the first-order conditions for the derivation of the domestic (politically) optimal non-cooperative policies in a representative sector of the economy are:

$$a\frac{\partial W}{\partial t} + I_E\frac{\partial W^E}{\partial t} + I_P\frac{\partial W^P}{\partial t} = 0, \tag{3.46}$$

$$a\frac{\partial W}{\partial \tau} + I_E\frac{\partial W^E}{\partial \tau} + I_P\frac{\partial W^P}{\partial \tau} = 0, \tag{3.47}$$

while foreign unilateral policies must satisfy

$$a^*\frac{\partial W^*}{\partial t^*} + I_E^*\frac{\partial W^{E*}}{\partial t^*} + I_P^*\frac{\partial W^{P*}}{\partial t^*} = 0, \tag{3.48}$$

$$a\frac{\partial W}{\partial \tau^*} + I_E^*\frac{\partial W^{E*}}{\partial \tau^*} + I_P^*\frac{\partial W^{P*}}{\partial \tau^*} = 0. \tag{3.49}$$

Substituting partial derivatives into (3.46) and (3.47), we obtain:

$$\begin{aligned}
&a\Big\{Y(\delta-1)+tY_p(\delta-1)+Y+\tau\Big[D_q\delta-Y_p(\delta-1)\Big]-D\delta\\
&-H\Big[(1-\theta)\beta Y_p(\delta-1)+\theta\beta^*Y_p^*\delta\Big]\Big\}\\
&-I_E s^E H\Big[(1-\theta)\beta Y_p(\delta-1)+\theta\beta^*Y_p^*\delta\Big]\\
&+I_P s^P HY(\delta-1)=0,
\end{aligned}\tag{3.50}$$

and

$$\begin{aligned}
&a\Big\{Y(1-\phi)+\tau(1-\phi)(D_q-Y_p)+D-Y+tY_p(1-\phi)-D(1-\phi)\\
&-H\Big[(1-\theta)\beta Y_p(1-\phi)-\phi\theta\beta^*Y_p^*\Big]\Big\}\\
&-I_E s^E H\Big[(1-\theta)\beta Y_p(1-\phi)-\theta\beta^*Y_p^*\phi\Big]\\
&+I_P s^P HY(1-\phi)=0.
\end{aligned}\tag{3.51}$$

Foreign environmental and trade policies must satisfy two symmetric conditions.

In Section 3.3.1, we derive the unilateral trade and environmental policies adopted by two symmetric countries by combining (3.44)-(3.45) with (3.50)-(3.51).

Cooperative Policies

In the case of cooperation, environmental and trade policies are chosen so as to maximize equation (3.17). Under the assumption of truthfulness of the political contributions, this implies the following first-order conditions:

$$a^*\Big[I_E\frac{\partial W^E}{\partial t}+I_P\frac{\partial W^P}{\partial t}\Big]+a\Big[I_E^*\frac{\partial W^{E*}}{\partial t}+I_P^*\frac{\partial W^{P*}}{\partial t}\Big]+aa^*\Big[\frac{\partial W}{\partial t}+\frac{\partial W^*}{\partial t}\Big]=0,\tag{3.52}$$

$$a^*\Big[I_E\frac{\partial W^E}{\partial \tau}+I_P\frac{\partial W^P}{\partial \tau}\Big]+a\Big[I_E^*\frac{\partial W^{E*}}{\partial \tau}+I_P^*\frac{\partial W^{P*}}{\partial \tau}\Big]+aa^*\Big[\frac{\partial W}{\partial \tau}+\frac{\partial W^*}{\partial \tau}\Big]=0,\tag{3.53}$$

$$a\Big[I_E^*\frac{\partial W^{E*}}{\partial t^*}+I_P^*\frac{\partial W^{P*}}{\partial t^*}\Big]+a^*\Big[I_E\frac{\partial W^E}{\partial t^*}+I_P\frac{\partial W^P}{\partial t^*}\Big]+aa^*\Big[\frac{\partial W}{\partial t^*}+\frac{\partial W^*}{\partial t^*}\Big]=0,\tag{3.54}$$

$$a\Big[I_E^*\frac{\partial W^{E*}}{\partial \tau^*}+I_P^*\frac{\partial W^{P*}}{\partial \tau^*}\Big]+a^*\Big[I_E\frac{\partial W^{E}}{\partial \tau^*}+I_P\frac{\partial W^{P}}{\partial \tau^*}\Big]+aa^*\Big[\frac{\partial W}{\partial \tau^*}+\frac{\partial W^*}{\partial \tau^*}\Big]=0. \tag{3.55}$$

Substituting partial derivatives into (3.52) and (3.53), we obtain:

$$\begin{aligned}
&a^*\Big\{-I_E s^E H\Big[(1-\theta)\beta Y_p(\delta-1)+\theta\beta^* Y_p^*\delta\Big]+I_P s^P HY(\delta-1)\Big\}\\
&+a\Big\{-I_E^* s^{E*} H^*\Big[(1-\theta^*)\beta^* Y_p^*\delta+\theta^*\beta Y_p(\delta-1)\Big]+I_P^* s^{P*} H^* Y^*\delta\Big\}\\
&+aa^*\Big\{Y(\delta-1)+tY_p(\delta-1)+Y+\tau\Big[D_q\delta-Y_p(1-\delta)\Big]-D\delta\\
&-H\Big[(1-\theta)\beta Y_p(\delta-1)+\theta\beta^* Y_p^*\delta\Big]\\
&+Y^*\delta+t^* Y_p^*\delta+\tau^*\delta(D_q^*-Y_p^*)-D^*\delta\\
&-H^*\Big[(1-\theta^*)\beta^* Y_p^*\delta+\theta^*\beta Y_p(\delta-1)\Big]\Big\}=0,
\end{aligned} \tag{3.56}$$

and

$$\begin{aligned}
&a^*\Big\{-I_E s^E H\Big[(1-\theta)\beta Y_p(1-\phi)-\theta\beta^* Y_p^*\phi\Big]+I_P s^P HY(1-\phi)\Big\}\\
&+a\Big\{-I_E^* s^{E*} H^*\Big[-(1-\theta^*)\beta^* Y_p^*\phi+\theta^*\beta Y_p(1-\phi)\Big]-I_P^* s^{P*} H^* Y^*\phi\Big\}\\
&+aa^*\{Y(1-\phi)+\tau(1-\phi)(D_q-Y_p)+D-Y+tY_p(1-\phi)-D(1-\phi)\\
&-H\Big[(1-\theta)\beta Y_p(1-\phi)-\theta\beta^* Y_p^*\phi\Big]\\
&-Y^*\phi-\tau^*\phi(D_q^*-Y_p^*)-t^* Y_p^*\phi+D^*\phi\\
&-H^*\Big[-(1-\theta^*)\beta^* Y_p^*\phi+\theta^*\beta Y_p(1-\phi)\Big]\Big\}=0.
\end{aligned} \tag{3.57}$$

Two symmetric expressions hold for the foreign country.

In Section 3.3.1, we derive the cooperative trade and environmental policies adopted by two symmetric countries by combining (3.44)-(3.45) with (3.56)-(3.57).

In the case of a free trade regime (Section 3.3.2), we set $\tau = \tau^* = 0$ and combine (3.44)-(3.45) with (3.50) and (3.56) to solve for the equilibrium unilateral and cooperative environmental taxes.

Finally, in the case in which trade policy is the only instrument (Section 3.3.3), unilateral and cooperative equilibrium tariffs are obtained by setting $t = t^* = 0$ and combining (3.44)-(3.45) with (3.51) and (3.57).

Part II

Multi-dimensional Agreement Formation

Chapter 4

Issue Linkage and Issue Tie-in in Multilateral Negotiations

4.1 Introduction

International relations involve multiple dimensions of interaction. Even when these dimensions are not directly interdependent—in the sense that the effects of choices along one dimension are dependent on choices along the others—there can still be cross-issue *negotiation* linkage: by exchanging concessions across different policy dimensions, two countries may be able to achieve cooperation in situations where there would otherwise be no scope for mutual gains to be attained. Although this idea is not new,[1] its implications have so far only been examined in the context of bilateral negotiations, not multilateral negotiations.

The literature on multilateral international agreements has primarily been concerned with whether single-issue multilateral agreements are immune from the possibility of deviations by a subset of countries. Consistently with the single-issue nature of the problem it studies, this literature has built upon theories of coalition formation whereby members of a coalition coordinate *all* of their actions with other members.[2] Simply extending the concept of coalition structure to a multi-dimensional framework in order to characterize the viability of multilateral

[1] The point was first stressed by Raiffa (1982) and Sebenius (1983). For a recent application to North-South trade and environmental policy cooperation, see Abrego *et al.* (1997).

[2] For an extensive survey of this literature, see Bloch (1997).

cooperation arrangements can be misleading, because it does not account for the fact that countries can (and often do) form selective arrangements with different partners over different issues.

Here we draw a distinction between the idea of issue linkage—which refers to the *possibility* of forming agreements over multiple issues—and that of issue tie-in—the requirement that agreements *must* span multiple dimensions of interactions, ruling out single-issue agreements. Multilateral cooperation across different issues (issue linkage) is an equilibrium phenomenon, whereas negotiation tie-in is an exogenous constraint on the set of possible cooperation arrangements. Whether such a tie-in restriction helps or hinders multilateral cooperation depends on the payoff structure of the underlying non-cooperative game. In some cases negotiation tie-in can facilitate multilateral cooperation by limiting the set of the feasible objections to joint cooperation arrangements. However, in other cases, rather than inducing parties to trade across issues, a tie-in restriction can actually constitute an obstacle to multilateral cooperation, as it removes certain counterobjections that could be put forward, out of equilibrium, in order to support issue trading in equilibrium.

We build our argument by presenting a model of international policy coordination choices where countries can enter into selective and separate binding agreements with different partners along different policy dimensions. International relations are described as a two-stage game, in which agreements are formed in the first stage and policies are selected in the second stage—cooperatively among countries participating in an agreement and non-cooperatively between countries belonging to separate agreements. To accommodate for the possibility of individual countries belonging to multiple agreements, we define an equilibrium concept built on a formal distinction between *agreements*, as arrangements that determine the payoff structure in the last stage of the game, and blocking *coalitions*, as subsets of players that can make objections to a proposed configuration of agreements in the first stage. Using this construct, we examine how the stability of the joint global agreement (the agreement structure where all players jointly cooperate over all strategic dimensions) is affected by the imposition of a tie-in rule, a constraint limiting the set of feasible objections to those featuring a simultaneous deviation across all issues for each player involved—which in turn amounts to only consid-

ering coalitions of players, rather than general agreement structures.

We then focus on a more specific model where countries are linked by international trade and transboundary pollution. In this context, the presence of a tie-in rule would imply that trade cooperation is conditional on environmental cooperation and viceversa. This would be in line with the idea, often discussed in the policy debate on trade and environment, that the WTO should act as an international policing organism, forcing countries to cooperate over issues that do not strictly pertain to trade policy narrowly defined.[3] It should be stressed, however, that the prevalent position in policy circles seems to be that the WTO should just accommodate the aims of the parties to multilateral environmental agreements (MEAs),[4] without directly extending its reach to cover environmental issues, thus rejecting conditionality as a means of promoting compliance.[5]

In this model, we show that, while in some cases the stability of a joint multilateral agreement is unaffected or enhanced by tie-in, in others a formal tie-in constraint can make an otherwise stable joint multilateral agreement unstable. The possibility of each scenario occurring is illustrated by means of parameterized examples, for which we derive players' payoffs under alternative agreement structures and bargaining rules. Negotiation tie-in is more likely to facilitate multilateral cooperation in situations where the environmental policy stakes are small relative to the welfare effects of trade policies and when partial environmental coordination is preferred to no cooperation by all countries involved, implying that outsiders

[3] On this point, see Whalley and Hamilton (1996).

[4] For a discussion of issues related to the integration of multilateral environmental agreements within the GATT/WTO see Esty (1994) and Brack (1997). Such integration would require a new interpretation of WTO rules, or possibly even textual amendments to them, so as to legitimize the use of trade restrictions in accordance with multilateral environmental agreements such as the Basle Convention on flows of toxic wastes, the Montreal Protocol on ozone layer depletion or the Kyoto Protocol on greenhouse gas emissions. This latter approach is reflected in several speeches made at the WTO High Symposium on Trade and Environment held in Geneva from 15-16 March 1999, which are available on the WTO web site.

[5] On several occasions the WTO has strongly rejected the prospect of "becoming an international body with unilateral powers [...], a world policeman that can force compliance upon unwilling governments"; see, for example, the address given by WTO Director General Renato Ruggiero to the Bellerive/Globe international conference in "Policing the Global Economy", on 23 March 1998.

can free-ride effectively on partial environmental agreements. On the other hand, when the costs of environmental compliance are high but the ability to free-ride on partial environmental agreements is limited, a negotiation tie-in restriction can hinder multilateral cooperation by making it both attractive and viable for a single country to remain outside of any agreement.

The remainder of the chapter is organized as follows. Section 4.2 describes a cooperative game of multi-dimensional agreement formation and defines the notion of Stable Agreement Structure. Section 4.3 contrasts issue linkage and issue tie-in, discussing their respective implications for the stability of a joint multilateral agreement. Section 4.4 applies these ideas to a simple three-country example in which countries can form trade and environmental agreements. Finally, Section 4.5 offers some concluding remarks.

4.2 Multi-dimensional Agreement Formation

In this section we formalize cooperation choices in an environment where players enter into separate agreements with different partners on different policy dimensions.

4.2.1 Strategies, Agreements and Behaviour

Consider the following strategic-form game. Let I be the set of players and let the strategy space for each player $i \in I$, Σ_i, be an $N(i)$-dimensional vector space, with $N(i) \in N, i \in I$, representing the number of dimensions in each player's strategy. Strategies for player i are denoted by $\sigma_i \in \Sigma_i$.

Assumption 4.1 $\Sigma_i = \times_{j \in \{1,\ldots,N(i)\}} \Sigma_{i,j}, i \in I$, *where the* $\Sigma_{i,j}, i \in I, j \in N(i)$ *are one-dimensional sets.*

Assumption 4.1 means that the pure strategy space for each player can be represented as the Cartesian product of one-dimensional sets. This ensures that choices along individual dimensions of the strategy vector can be made independently of each other, i.e. individual dimensions of strategic choice are not directly linked.[6]

[6]The reason for this assumption will be made clear later. Nevertheless, note that it involves no loss of generality. Starting from any given game, it is always possible to augment the strategy

Definition 4.1 *The sets* $\Sigma_{i,j}, i \in I, j \in N(i)$ *are* elementary strategy *sets and their elements* $\sigma_{i,j}$ elementary strategies.

The space of strategy profiles is $\Sigma \equiv \times_{i \in I} \Sigma_i = \times_{i \in I} \times_{j \in \{1,\dots,N(i)\}} \Sigma_{i,j}$, and strategy profiles are $\sigma \in \Sigma$. Players' payoffs are represented by real-valued mappings $\pi_i : \Sigma \mapsto R,\ i \in I$.

In analyses of coalition formation, coalitions are described as non-empty subsets of I, and this is then interpreted as meaning that the players in each subset pool all of their elementary strategies and make coordinated choices over them. If we are to separately represent different dimensions of choice, then coalitions can be defined as follows. Let $S(i) \equiv \{s \equiv (i,j) \,|\, j \in \{1,\dots,N'(i)\}\},\ i \in I$—i.e. $S(i)$ is the set of pairs $s = (i,j)$ such that j is a valid dimension of player i's strategy vector (i.e. s corresponds to a valid index pair (i,j) for elementary strategies σ_{ij})—and $S \equiv \bigcup_{i \in I} S(i)$—i.e. each element of S corresponds to a different elementary strategy. Finally, let P be a partition of S whose elements are the sets $S(i)$, $i \in I$. Then, a coalition structure C consists of a partition of S which is coarser than P, i.e. such that all of a player's elementary strategies belong to a single element of the partition. For the purpose of our analysis, we wish to examine situations where a subset of players coordinate their actions with each other only with respect to certain strategy dimensions and not others, and where the same player can enter into different coordinating arrangements with different players for different strategy dimensions. To allow for this, one can simply drop the requirement that the partition of the set of elementary strategies be coarser than P, and allow instead for arbitrary partitions of S. The resulting partitions G will be called *agreement structures* and their elements g will be called *agreements*. The sub-profile of elementary strategies in the agreement will be denoted by $\sigma^g \equiv (\sigma_s \,|\, s \in g)$, and the set of such sub-profiles—the strategy set of agreement g—will be denoted as Σ^g.

Definition 4.2 *An* agreement $g \in S$ *is a subset of strategy dimensions for a subset of players.*

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set by redefining it as having rectangular support as required by Assumption 4.1, and then assign an infinite negative payoff for all players to any strategy profile involving the added strategies.

Note that Assumption 4.1 ensures that a player assigns elementary strategies to different agreements, the strategy sets of the different agreements are independent sets.[7]

Definition 4.3 *A* participant *to agreement* g, $\tilde{i}^g \in \{i \in I \mid (i,j) \in g \text{ for some } j\}$, *is a player who contributes at least one elementary strategy to the agreement. The set of participants to agreement* g *is denoted by* I^g.

We shall focus on subgame-perfect equilibria of a two-stage game where players first enter into binding cooperative agreements and then the resulting agreements interact non-cooperatively. Starting from the last stage, let the vector of payoffs for the participants to agreement g be denoted by $\pi^g(\sigma) \equiv (\pi_i(\sigma) \mid i \in I^g)$.

Assumption 4.2 *(Agreements' behaviour) Each agreement* $g \in G$ *chooses* $\sigma^g \in \Sigma^g$ *so as to attain a maximal element of* $\Pi^g(\sigma^g, \sigma^{-g}) \equiv \{\pi^g(\sigma^g, \sigma^{-g}) \mid (\sigma^g, \sigma^{-g}) \in \Sigma\}$ *(where* $-g$ *stands for* $G - g$*). The best-reply correspondence of agreement* g, $\hat{\sigma}^g : \Sigma \mapsto \Sigma$, *is thus defined as* $\hat{\sigma}(\sigma^{-g}) = \arg\sup_{\sigma^g} \Pi^g(\sigma^g, \sigma^{-g})$.

This assumption simply generalizes best-response behaviour by individual players in a non-cooperative setting to a decision-making unit involving multiple players: no agreement $g \in G$ can do (Pareto) better than play σ^g, given the behaviour of all other agreements (σ^{-g}).

Definition 4.4 *A* non-cooperative outcome *for the agreement structure* G *is a strategy profile* $\tilde{\sigma}$ *such that* $\tilde{\sigma}^g \in \hat{\sigma}(\tilde{\sigma}^{-g})$, $g \in G$. *The set of non-cooperative outcomes for the agreement structure* G *is denoted by* $\tilde{\Sigma}(G)$.

4.2.2 Stable Agreement Structures

Agreement formation in the first stage of the game is formalized using ideas from cooperative game theory. We define a Core-like equilibrium concept whereby subsets of players can put forward objections to a certain proposed arrangement, as

[7] Cross-linkage between strategy sets is a complication that is typically assumed away in the analysis of strategic-form games and that does not arises when players, having independent strategy sets but possibly not independent choices along different dimensions, form coalitions in the more restrictive sense of the term.

in Ray and Vohra (1997). Here, however, we make a formal distinction between *agreements* among players to coordinate the use of (one or more) strategies, and *coalitions* of players who can make coordinated objections to a proposed agreement structure. The two concepts are logically distinct: agreement structures determine payoffs in the second stage of the game; coalitions of players can object to a proposed arrangement by rearranging the strategies they control, but such objections do not necessarily imply the formation of agreements between the objecting players.[8]

In order to describe our equilibrium concept, it is convenient to redefine the game by "breaking up" the individual players into smaller units each corresponding to a different elementary strategy:

Definition 4.5 *An* elementary player *is a pair* $(s = (i, j) \in S, \pi_i)$*, i.e. an element of* S *paired with the payoff mapping of the player to which the elementary strategy* s *belongs. The payoff mapping for elementary player* s *is denoted by* π_s*.*

No problem of interpretation arises with respect to the second stage of the game: under Assumption 4.2, the set of non-cooperative outcomes will be the same whether we describe the game in terms of players $i \in I$ or in terms of elementary players $s \in S$. With respect to the formulation of objections to a certain agreement, although we do not require that individual elementary players who share the same payoff coordinate their objections, such coordination will not be ruled out by our equilibrium concept. In other words, elementary players who share the same payoff may still choose to act as a single player.

We shall also need the following definitions:

Definition 4.6 *A* restricted agreement structure $\tilde{G}(S')$*,* $S' \subseteq S$ *is a partition of* S'*.*

Definition 4.7 *An* unrestricted agreement structure *is an agreement structure restricted to* S*.*

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[8]In partition function games (games "with externalities"), it is possible for two players to obtain a higher payoff by acting individually than by coordinating their actions, because of the effect of a third player's response on the non-cooperative outcome. Achieving such an outcome, however, may require abiding by a common, coordinated coalitional choice (i.e. both players must together choose to act in this way).

Also let $\mathcal{G}$ denote the set of all possible partitions of S, and $\bar{\mathcal{G}} \subseteq \mathcal{G}$ the set of the *feasible* agreement structures, where feasibility is a function of institutional or other constraints.

Our equilibrium concept can then be described in terms of the two following definitions:

Definition 4.8 *A restricted agreement structure* $\tilde{G}(S')$, $S' \subseteq S$ *can be* blocked, *within an agreement structure* $G' \equiv \tilde{G}(S') \bigcup \tilde{G}(S - S')$, *by a coalition* $S'' \subseteq S'$ *of elementary players if there exists a restricted agreement structure* $\tilde{G}(S'')$*—involving only elementary players in the blocking coalition—such that, for each of the restricted structures* $\tilde{G}(S' - S'')$*—involving the remaining elementary players in* S'*—that cannot be blocked under the combined structure* $G'' \equiv \tilde{G}(S'') \bigcup \tilde{G}(S' - S'') \bigcup \tilde{G}(S - S') \in \mathcal{G}$, *we have that (i)* $\forall \hat{\sigma}(G'') \in \hat{\Sigma}(G'')$, $\forall \tilde{\sigma}(G') \in \tilde{\Sigma}(G')$, *it is the case that* $\pi_s(\tilde{\sigma}(G'')) \geq \pi_s(\tilde{\sigma}(G'))$, $s \in S''$, *with the inequality being strict for at least one* $s \in S''$*; and (ii)* $\tilde{G}(S' - S'')$ *can be blocked within* G''.[9] *If* $\tilde{G}(S'')$ *satisfies the above conditions, we say that it is a* stable objection *to* $\tilde{G}(S'')$ *by* S''.

Definition 4.9 *A* Stable Agreement Structure G^* *is an unrestricted structure which cannot be blocked.*

Note the recursive nature of the above definition: what is required for an objection by a coalition of players to constitute a blocking objection is that it must be not only profitable (condition (i)) but also immune from further external or internal deviations, i.e. it must involve an arrangement that is stable (in the restricted sense) according to the very definition of stability so obtained.[10] In this construct, objections are made by subsets of elementary players—*coalitions* in the standard sense of cooperative game theory—who make alternative arrangements among themselves without involving the other players. Although such objections

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[9] According to this definition, an objection is viable for a coalition only if it yields a Pareto superior outcome for its members under *all* stable counterobjections that the other players can put forward. This idea is analogous to Greenberg's (1990) concept of "pessimistic standard of behaviour".

[10] This consistency requirement, ruling out coalitional deviation which are not themselves immune from further deviations, also characterizes equilibrium concepts such as the Coalition-Proof Nash Equilibrium of Bernheim, Peleg and Whinston (1987) and the Equilibrium Binding Agreements of Ray and Vohra (1997).

are coordinated, they do not necessarily involve pooling all the corresponding elementary strategies into a single agreement.

This specification does away with the need for exogenous rules describing the fate of agreements under an objection involving a subset of its participants (as discussed by Burbidge *et al.*, 1997): in this definition, stable arrangements can reform for any restricted set of players, once an objection is made. Also, although objections are made by successively finer coalitions—as in Ray and Vohra (1997)—the objections themselves can consist of agreement structures that are coarser than the one to which a coalition objects to.[11]

The concept of Stable Agreement Structure appears to be a natural extension of similar equilibrium concepts that have been described for games of coalition formation; as is the case for these analogous solution concepts, existence of an equilibrium may in general be problematic. In practice, the concept of Stable Agreement Structure may also be difficult to operationalize owing to the large number of potential objections and counterobjections that are involved. In our application, however, we shall focus on a scenario with only three players and two dimensions of choice, where the solution concept becomes manageable.

4.2.3 Within-agreements Bargaining

Without additional restrictions, Assumption 4.2 does not tie down behaviour to a specific distributional objective, and does not rule out asymmetric payoff outcomes within an agreement where all participants are identical. This flexibility implies that there will typically exist a continuum of non-cooperative equilibria for any agreement structure. In the rest of our analysis, we shall narrow down the set of possible non-cooperative outcomes by assuming a fixed payoff distribution rule within an agreement g, arising as the solution to a bargaining problem among the participants to g. As elsewhere in this literature (e.g. Burbidge *et al.*, 1997) we shall assume the bargaining rule to be anonymous (i.e. symmetric), implying that identical players in identical situations must obtain the same payoff.

A symmetric bargaining rule involves two ingredients: the set of efficient (within the agreement) payoff combinations that can be attained if players form g, and the

[11] Under the Equilibrium Binding Agreement rule of Ray and Vohra (1997), existing agreement structures are allowed to break only into smaller agreements.

"disagreement" payoffs of participants, $\pi_i^{Dg}, i \in I^g$. Given these, optimal policy choices by an agreement can be characterized as the policy combination (or set of combinations) which maximizes $B(\pi_i - \pi_i^{Dg}, i \in I^g)$, where B is a symmetric. concave function.[12]

Consistently with our characterization of stability, the disagreement point D should be based on the stable outcomes that prevail if a certain agreement were not to form. In turn, stability of the disagreement point depends on the payoff distribution in alternative agreements, which implies that the characterization of the disagreement payoffs for the various agreements is linked, recursively, to the characterization of stability of the restricted structures that are involved in the various objections an counterobjections.[13] One can interpret this specification as implying an initial pre-agreement stage where players can unilaterally commit not to enter into certain agreements with certain partners. Since such a commitment by *any* single player would automatically result in the removal of the corresponding agreement structures from the set of feasible structures, the disagreement point is naturally defined as that payoff distribution that would result within the resulting restricted space of agreement structures. In the application of 4.4, we shall focus on a scenario where, in the "pre-game" stage, players can unilaterally veto the possibility that *any* agreement will form, in which case the disagreement point D is taken from the payoff combinations that prevail when all agreements are singletons (i.e. no agreements form).[14]

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[12]It is natural here to rely on a simple extension of two-player bargaining ideas to multi-player bargaining, rather than resort to the multi-player bargaining solution concepts that have been proposed for superadditive coalition-form games (games without "externalities"), such as the Shapley value. Such solution concepts define a division rule for the gains from multilateral cooperation based on the distribution of payoffs under alternative coalitional outcomes. Our definition of a stable outcome already calls upon a comparison of payoff outcomes under agreements structures; furthermore, in our construct the bargaining rule is relied upon to determine a payoff division within agreements for *any* agreement structure, not just the grand coalition.

[13]This approach is consistent with the extensions of the Shapley Value for coalitional form games proposed by Aumann and Myerson (1988).

[14]The more general case can be formally described as follows. Let $Z \equiv \{g \subseteq S\}$, X be a partition of Z with $A \in X$ representing an element of this partition; define $\mathcal{A}(g) \equiv \{G \in \mathcal{G} \mid g \in A, A \bigcap G \neq \emptyset\}$, and $\check{\mathcal{G}}(g) \equiv \mathcal{G} - \mathcal{A}(g)$. Also, let $\mathcal{G}^*(\mathcal{G})$ denote the set of stable agreement structures given $\mathcal{G}$ as the (possibly restricted) set of feasible agreement structures, and $\tilde{G}^* : \{\mathcal{G}\} \mapsto \mathcal{G}$ be a mapping which selects one specific structure from a set (with $\{\mathcal{G}\}$ representing a collection of sets). Then, under a symmetric bargaining rule, behaviour can be defined in the following way:

There is a further complication, arising from the non-superadditive structure of the game: when a subset of players form an agreement, it is possible that the payoffs they can obtain are less than the payoffs that are feasible in the absence of the agreement; thus, the fallback position may involve higher payoffs than are possible in the presence of the agreement itself. It is true that, if this is the case, then the corresponding agreement structure could never be stable according to our definition. Nevertheless, in order to apply our definition of blocking and stability, a payoff distribution must be defined for *all* agreement structures, even those that are not stable. To deal with such cases, we can apply the bargaining function B "in reverse" by taking the cum-agreement scenario as defining the (endogenously determined) disagreement point and the stable no-agreement scenario as defining the (exogenously determined) bargaining outcome.[15]

Some remarks are in order at this point with respect to the feasibility of side payments. The agreement formation game as we have formalized it above does not rule out the possibility of side payments, if feasible. Side payments can be formally treated just like additional dimensions of players' strategies, which become active only within agreements in which the corresponding elementary players participate. In the game so augmented, all of the previous definitions would still apply, both in the general case and in the case of a bargaining-based payoff distribution rule within agreements.

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for a given restricted set of agreement structures $\mathcal{G}$, each agreement $g \in G \in \mathcal{G}$, chooses $\sigma^g \in \Sigma^g$ so as to maximize $B(\pi_i - \pi_i^{Dg}(\mathcal{G}), i \in I^g)$, where $\pi_i^{Dg}(\mathcal{G}) = \pi_i(\hat{\sigma}(\tilde{G}^*(\mathcal{G} - \check{\mathcal{G}}(g))))$. Note that such a definition recursively invokes the definition of stability for a structure *within* a certain restricted set of structures, and is therefore intertwined with Definitions 4.8 and 4.9: in order to determine the payoff distribution within an agreement in a certain structure, it is necessary to determine which structure would be stable if the structures in $\mathcal{A}(g)$ were eliminated; in turn this determination may require knowledge of the payoff distribution within a certain agreement g' in alternative structures, which then may require identifying a further stable outcome in a game where further both the structures in $\mathcal{A}(g)$ and in $\mathcal{A}(g)'$ are ruled out; and so on. The simple version of this construct we use in Section 4.4 assumes X to consist of the single element Z.

[15] In a scenario with symmetric players, it is possible to abstract from this problem by simply assigning equal payoffs to identical players, which may nevertheless result in lower payoffs when a certain agreement is present than without it. Even in this case, however, the use of an equal-payoff rule would imply the application of a symmetric bargaining rule, where the disagreement point is defined as the payoff distribution which results in a structure where the agreement in question does take place.

4.3 Issue Linkage vs. Issue Tie-in

The multi-dimensional agreement formation game described in the previous section naturally involves issue linkage, i.e. players *can* cooperate over multiple dimensions and bargain across different issues. Such cooperation and exchange may involve the formation of perfectly overlapping agreement structures (i.e. coalitions of player in the standard sense) or only partially overlapping structures (with subsets of players cooperating over certain issues but not others). A negotiation tie-in rule, requiring that countries *must* form joint agreements over multiple issues—coalitions in the usual sense of the term—eliminates the possibility of partially overlapping agreement structures, which affects both the feasible proposals as well as the feasible objections to a given proposal. The question we want to address here is the following: what are the implications of a tie-in rule for the stability of the *Joint Global Agreement* (JGA), $J \equiv \{\{S\}\}$—the agreement structure where all players jointly cooperate over all strategic dimensions?

Formally, let $\hat{\mathcal{G}}$ the set of partitions of S which are coarser than P (where P is the partition of S whose elements are the sets $S(i)$, $i \in I$).

Definition 4.10 *A* perfectly overlapping *agreement structure is an element of* $\hat{\mathcal{G}}$. *A* partially overlapping *agreement structure is an element of* $\mathcal{G} - \hat{\mathcal{G}}$.

A negotiation tie-in rule restricts agreements to lie in $\hat{\mathcal{G}}$. Note that since the JGA belongs to $\hat{\mathcal{G}}$, it is not ruled out by a tie-in restriction. Nevertheless, such a tie-in restriction may affect the stability of the JGA as it affects the set of feasible objections and counterobjections.

Suppose that, without a tie-in restriction, the set of feasible agreement structures is simply $\bar{\mathcal{G}} = \mathcal{G}$, and let the sets of Stable Agreement Structures with and without a tie-in restriction be respectively denoted as $\mathcal{G}^R$ and $\mathcal{G}^U$. Then, theoretically four possibilities arise: (i) $J \in \mathcal{G}^R \bigcap \mathcal{G}^U$; (ii) $J \in \mathcal{G}^R - \left(\mathcal{G}^R \bigcap \mathcal{G}^U\right)$; (iii) $J \in \mathcal{G}^U - \left(\mathcal{G}^R \bigcap \mathcal{G}^U\right)$; (iv) $J \notin \mathcal{G}^R \bigcap \mathcal{G}^U$. In cases (i) and (iv), a tie-in restriction is irrelevant for the stability of the JGA: in case (i) it is stable with or without a tie-in restriction, whereas in (iv) it is unstable under both scenarios. In case (ii), a tie-in restriction makes J stable when it would not be otherwise; in case (iii) it makes J unstable.

The implicit, informal presumption in the policy debate seems to be that tie-in

could "help" cooperation, by forcing asymmetric countries to trade concessions across different issues and by offsetting free-riding incentives.[16] The broad idea behind our counter argument is that what matters for countries to be persuaded to cooperate across all issues is that cross-trading be *possible* out of equilibrium, not that it be *required*. In other words, the idea of cross-issue trade focuses on within-coalitions bargains, but the formation of an agreement (and the associated bargaining that takes place within it) is an equilibrium phenomenon, which may or may not occur depending on whether other arrangements can be opposed as objections. From this point of view, the effect of a tie-in rule is, in principle, ambiguous: it could either make the JGA stable—by eliminating a partially overlapping agreement structures that would otherwise constitute a stable objection to it as in case (ii) above—make the JGA unstable—by eliminating a partially overlapping agreement structure that would otherwise make a certain perfectly overlapping structure unstable as an objection as in case (iii) above—or, finally, have no effect.

To illustrate these ideas, consider the following stylized example. There are three players 1, 2, and 3. Player 1 has two elementary strategies, denoted as A_1 and B_1, while players 2 and 3 have only one elementary strategy each, denoted respectively as A_2 and A_3. Suppose that to each agreement structure corresponds only one non-cooperative equilibrium, and that payoffs under the JGA, $J = \{\{A_1, B_1, A_2, A_3\}\}$ are $\pi_i = 3,\ i \in \{1, 2, 3\}$.

Consider first a scenario where $\pi_i = 3,\ i \in \{1, 2, 3\}$ in the JGA, $\pi_1 = \pi_2 = 4$, $\pi_3 = 0$ under $G^1 = \{\{A_1, A_2\}, \{B_1\}, \{A_3\}\}$, and $\pi_i = 1,\ i \in \{1, 2, 3\}$ in all other agreement structures. Then if, under a tie-in restriction, G^1 is ruled out, J is stable, whereas if it is feasible, players 1 and 2 can block J by putting forward G^1, which in turn cannot be blocked by any agreement structure. Here, negotiation tie-in helps support multilateral cooperation.

Consider next a scenario where the agreement structure $G^2 = \{\{A_1, B_1, A_2\}, \{A_3\}\}$—the structure where players 1 and 2 form a coalition—yields payoffs $\pi_1 = \pi_2 = 4, \pi_3 = 0$, and all perfectly overlapping structures other than J and G^2 yield

[16] For example, Carraro and Siniscalco (1994) point out that free-riding incentives could be offset by making the signing of agreements entailing positive excludable externalities restricted to signatory countries (e.g. trade or R&D agreements) *conditional* on environmental cooperation.

$\pi_i = 1,\ i \in \{1,2,3\}$. Since both players 1 and 2 are better off under G^2 than under J, the configuration G^2 could in principle constitute a blocking objection to J for them. It remains to be seen whether G^2 itself is stable with respect to restricted counterobjections (objections made by finer blocking coalitions). The only candidate counterobjections by subsets of the objecting coalition $\{1,2\}$ are $G^3 = \{\{A_1,B_1\},\{A_2\},\{A_3\}\}$, $G^4 = \{\{A_1,A_2\},\{B_1\},\{A_3\}\}$, and $G^5 = \{\{A_1\},\{B_1\},\{A_2\},\{A_3\}\}$. Under a tie-in restriction, however, G^4 and G^5 are infeasible. Suppose that, under G^3 and G^5, we have $\pi_i = 1$, while under G^4 we have $\pi_1 = 5$, $\pi_2 = 1$, $\pi_3 = 0$. Then, if G^3 is the only possible counterobjection to G^2, the latter will be a stable objection to J, and therefore J will not be stable. If, on the other hand, there is no tie-in restriction, G^4 and G^5 are feasible counterobjections, and player 1 can block G^2 by putting forward G^4—which is itself stable, since G^5, the only possible counterobjection to G^4, yields a lower payoff for player 2 than G^4 does, and player 2 obtains a lower payoff under G^4 than under J. Thus, without a tie-in restriction, G^2 is not a stable objection to J, and J is therefore stable. In this scenario, a tie-in restriction hinders multilateral cooperation.

Notice that issue *linkage* can still be at work in the same scenario. Suppose, for example, that countries were forced to coordinate over different issues *separately*—which would rule out both G^2 and J (as well as all the agreement structures involving the elementary player B_1 and any other player)—and that $G^6 = \{\{A_1,A_2,A_3\},\{B_1\}\}$ (a multilateral agreement over a single dimension) yields payoffs $\pi_i = 0,\ i \in \{1,2,3\}$. Then multilateral cooperation over the first policy dimension would not be possible unless the other dimension is also brought in.

Whether a tie-in restriction will help or hinder multilateral cooperation therefore depends on the payoff structure of the underlying non-cooperative game. In the next section, we describe a policy game involving both trade and environmental policies—based on a competitive model of international trade with internationally differentiated goods and transboundary pollution—which we then use to examine the implications of negotiation tie-in across trade and environmental policies for the stability of multilateral, joint trade-and-environment policy agreements.

4.4 An Application to International Negotiations on Trade and the Environment

Much of the literature on international policy cooperation has separately examined cooperation over trade policies and over environmental policies. Riezman (1985), Krugman (1991), Bond and Syropoulos (1993), and Yi (1996), among others, have focused on the creation of customs unions (CUs), while Carraro and Siniscalco (1993), Barrett (1994) and Chander and Tulkens (1992), among others, have focused on International Environmental Agreements (IEAs). The broad theme emerging from this literature is that the presence of spillovers between coalitions (positive in the case of environmental coalitions, negative in the case of trade coalitions) makes global cooperation difficult to sustain, and that partial cooperation, restricted to subsets of countries, is more likely to emerge.

In this context, it has been suggested that multilateral cooperation could be enhanced by formally combining different issues with the aim of joint settlement. In the following, the ideas developed in the preceding sections will be used to examine formally the question of whether negotiation tie-in across trade and environmental policy issues would help or hinder multilateral cooperation. For this purpose, we describe a three-country model of international trade with transboundary pollution.[17]

4.4.1 International Trade with Transboundary Pollution

Three ex-ante symmetric countries, 1, 2 and 3, are linked by transboundary pollution and trade, with markets for traded goods being characterized by perfect competition. Environmental emissions are "global", i.e. countries are equally affected by foreign and domestic emissions. Each country $i \in I \equiv \{1, 2, 3\}$ is en-

[17]It can be argued that, in the absence of a supranational authority with autonomous powers of effective enforcement, it is not legitimate to assume international commitments to be binding, and that therefore all international agreements must be self-enforcing. This type of approach to the analysis of international trade agreements, using an infinitely repeated game paradigm, has been pursued, among others, by Bagwell and Staiger (1997). Note, however, that the structure of incentives that makes cooperation sustainable by threat of punishment in a repeated game finds a counterpart in the sequence of objections and counterobjections in our static solution concept. On the other hand, since punishment strategies in a repeated game can be arbitrarily selective, such correspondence would be weakened if only multi-issue agreements were included.

dowed with an amount $\bar{M}_i$ of a non-traded good. In each country, firms in the tradeable goods sector produce a single good at a constant marginal cost $c = 1$ in terms of the nontraded good. Markets are assumed to be segmented, in the sense that consumers in each country view goods produced in different countries as being imperfect substitutes.

Consumers are identical, and the preferences of the representative consumer in country $k \in I$ are described by a quasilinear, isoelastic utility function:

$$u_k(M_k, Q_k) \equiv M_k + \frac{\beta}{1+1/\eta} Q_k^{1+1/\eta} - \frac{\delta}{1+1/\theta} D^{1+1/\theta}, \quad k \in I, \tag{4.1}$$

where M_k is consumption of the nontraded good, Q_k is composite consumption of the traded goods—an isoelastic aggregation of the quantities q_{ik} produced in country i (origin) and consumed by country k (destination), i.e.

$$Q_k = \left[(1-\mu)^{1/\gamma} q_{kk}^{(\gamma-1)/\gamma} + (\mu/2)^{1/\gamma} \sum_{i \neq k} q_{ik}^{(\gamma-1)/\gamma} \right]^{\gamma/(\gamma-1)}, \tag{4.2}$$

with γ representing the elasticity of substitution in consumption between traded goods from different sources, and μ representing the share of imports in total tradeables demand—$\eta < 0$ is the (constant) elasticity of demand for the tradeables aggregate, β is a positive scalar, D are global emissions, $\theta > 0$ is the (constant) inverse elasticity of marginal damage valuation with respect to global emissions, and δ is a positive scalar.

Demand for the traded aggregate in country k is then given by

$$Q_k = [p_k/(\beta m_k)]^{\eta}, \quad k \in I, \tag{4.3}$$

where

$$p_k = \left[(1-\mu) w_{kk}^{1-\gamma} + (\mu/2) \sum_{i \neq k} w_{ik}^{1-\gamma} \right]^{1/(1-\gamma)}, \quad k \in I, \tag{4.4}$$

m_k is the price of the nontraded good in country k, and w_{ik} is the consumer price in country k of goods imported from country i. Using Shephard's Lemma, we can write uncompensated demands for imports and domestic demand for domestically produced tradeables as

$$q_{ik} = \left(\frac{p_k}{\beta m_k} \right)^{\eta} \alpha_{ik} \left(\frac{p_k}{w_{ik}} \right)^{\gamma}, \quad i \in I, k \in I, \tag{4.5}$$

where $\alpha_{ik} = \mu/2,\ i = k$, and $\alpha_{kk} = 1 - \mu,\ i \neq k$.

Production of the traded good in country i generates environmental emissions that are proportional to output by a certain fixed factor, the same for all countries, which, without loss of generality can be assumed to be equal to unity. Global emission are then simply

$$D \equiv \sum_{ik} q_{ik}, \quad k \in I, \tag{4.6}$$

We restrict the government in country k to the use of only two policy instruments: ad valorem output taxes (e_k)—which, since emissions are proportional to output, are equivalent to emission taxes—and discriminatory, ad valorem imports tariffs (t_{ik}). Tax and tariff revenues are returned to consumers in a lump-sum fashion.

Domestic demand for nontradeables is

$$M_i = \frac{m_i \bar{M}_i + \sum_k [e_i m_i q_{ik} + t_{ki} m_k (1 + e_k) q_{ki}] - p_i Q_i}{m_i}, \quad i \in I. \tag{4.7}$$

Market clearing then requires

$$M_i + \sum_k q_{ik} - \bar{M}_i = 0, \quad i \in I. \tag{4.8}$$

Zero-profits for the tradeable goods sector in country i require that the gross-of-tariff, gross-of-tax, consumer price of imports from i by k must be

$$w_{ik} = m_i (1 + e_i)(1 + t_{ik}), \quad i, k \in I. \tag{4.9}$$

For the purpose of our analysis, countries' payoffs are defined as the sum of consumer surplus, and tariff and tax revenues, minus environmental damage, which is in turn equal to the difference between utility and the endowment $\bar{M}_i$:

$$\pi_i = u_i(M_i, Q_i) - \bar{M}_i. \quad i \in I. \tag{4.10}$$

This is simply a re-normalization of utility, which involves no loss of generality.

4.4.2 Feasible Agreement Structures

As discussed in Section 4.2, it is useful to redefine the game in terms of six *elementary players*, by breaking up each country i into two smaller players—its trade

and environment "ministers"—denoted respectively as T_i and E_i, who share the same payoff function, but control each trade and environmental policy for country i, respectively.

Note that in this setting there exist a unique welfare-maximizing combination of trade and environmental taxes in each country $i \in I$, for any given combination of taxes in the other countries,[18] this combination being a solution for the first-order conditions $\partial\pi_i/\partial t_{ik} = 0, k \in I$, and $\partial\pi_i/\partial e_i = 0$. In turn these conditions are equivalent to best-response conditions obtained by maximizing π_i separately by choice of $t_{ik}, k \in I$, and e_i, i.e. the conditions that characterize behaviour for two separate elementary players. In other words, in this setting, there is no direct gain for an individual player from coordinating choices across different policy dimensions. Thus, for example, agreement structures involving the single element $\{T_1, E_1\}$ and structures involving the separate elements $\{T_1\}, \{E_1\}$ will yield the same payoffs for all players.

For the purpose of our analysis—and consistently with observed practice—we shall restrict feasible agreement structures to those which involve only one policy dimension or both, i.e. trade-only agreements, environment-only agreements and joint agreements on trade and environment, thus ruling out mixed agreements where a country coordinates its trade policy with another country's environmental policies. Note, however, that the same equivalence of single-player optimal choice and elementary players' best responses applies here with respect to single-issue and two-issue agreements involving the same players, implying that we need not separately consider structures featuring joint agreements.[19] In other words, two separate agreements over trade and environmental policies respectively between two players are here the same as a joint (perfectly overlapping) agreement between the same two players.

With six elementary players and two strategy dimensions—and given the re-

[18] The payoff π_i is concave in e_i and t_{ik}.

[19] If, for example, two countries sign a trade agreement, their trade ministers will set trade taxes in a cooperative manner, taking as given the environmental taxes chosen by their respective environmental ministers. If the two countries sign an environmental agreement, their environmental ministers will set environmental taxes taking as given the trade taxes chosen by their respective trade ministers. If they sign both, all ministers will behave just as they would under each separate agreement, and this will entail no coordination failure.

striction imposed on the set of feasible agreement structures and the equivalence property discussed above—we need to consider twenty-five possible agreement structures, which, given the symmetry assumption, can be restricted to the following ten:

1. Joint Global Agreement (JGA):
   $\{\{T_1, T_2, T_3\}, \{E_1, E_2, E_3\}\}$;

2. No agreement on either issue:
   $\{\{T_1\}, \{T_2\}, \{T_3\}, \{E_1\}, \{E_2\}, \{E_3\}\}$;

3. Global trade agreement, no environmental agreement:
   $\{\{T_1, T_2, T_3\}, \{E_1\}, \{E_2\}, \{E_3\}\}$;

4. Global environmental agreement, no trade agreement:
   $\{\{T_1\}, \{T_2\}, \{T_3\}, \{E_1, E_2, E_3\}\}$;

5. Partial environmental agreement, no trade agreement:
   $\{\{T_1\}, \{T_2\}, \{T_3\}, \{E_1\}, \{E_2, E_3\}\}$;

6. Partial trade agreement, no environmental agreement:
   $\{\{T_1\}, \{T_2, T_3\}, \{E_1\}, \{E_2\}, \{E_3\}\}$;

7. Partial perfectly overlapping agreements on trade and environment:
   $\{\{T_1\}, \{T_2, T_3\}, \{E_1\}, \{E_2, E_3\}\}$;

8. Partial agreements on trade and environment:
   $\{\{T_1\}, \{T_2, T_3\}, \{E_1, E_2\}, \{E_3\}\}$;

9. Global trade agreement and partial environmental agreement:
   $\{\{T_1, T_2, T_3\}, \{E_1\}, \{E_2, E_3\}\}$;

10. Global environmental agreement and partial trade agreement:
    $\{\{T_1\}, \{T_2, T_3\}, \{E_1, E_2, E_3\}\}$.

The presence of a tie-in restriction only leaves the perfectly overlapping agreement structures 1, 2 and 7—and all symmetrically corresponding configurations—as feasible agreement structures.

4.4.3 Negotiation Tie-in and the Stability of the Joint Global Agreement

If we apply the equilibrium concept described in Section 4.2 to this environment, we can state the following:

Proposition 4.1 *A tie-in negotiation rule makes an otherwise unstable JGA stable if and only if: (a) under a tie-in restriction, no perfectly overlapping structure put forward by a coalition of one or more countries can block the JGA; and (b) when all agreement structures are feasible, a partially overlapping agreement structure is a stable objection to the JGA.*

In our three-country example, the conditions of Proposition 4.1 become:
(a) $\pi_i^1 > \pi_i^2$ and $\pi_i^1 > \pi_i^{7*}$ $\forall i$, where 7^* indicates agreement structure 7 and its mirror images;
(b.1) Within the set of partially overlapping agreement structures that a single country j could put forward as objections to the JGA (including agreement structures 5, 6, 9 and 10 and their mirror images), there is at least one structures G' for which: (i) $\pi_j^{G'} > \pi_j^1$; and (ii) within the set of agreement structures that the other two countries k and h can put forward as counterobjections to G', there is no structure G'' such that $\pi_k^{G''} \geq \pi_k^{G'}$ and $\pi_h^{G''} \geq \pi_h^{G'}$ (with at least one inequality being strict); and/or
(b.2) Within the set of partially overlapping agreement structures that two countries k and h can put forward as objections to the JGA (including agreement structures 3, 4, 5, 6 and 8 and their mirror images), there is at least one structures G' for which: (i) $\pi_k^{G'} \geq \pi_k^1$ and $\pi_h^{G'} \geq \pi_h^1$ (with at least one inequality being strict); and (ii) within the set of agreement structures that a third country j can put forward as counterobjections to G', there is no structure G'' such that $\pi_j^{G''} > \pi_j^{G'}$.

Proposition 4.2 *A tie-in negotiation rule makes an otherwise stable JGA unstable if only if: (a) under a tie-in restriction, a perfectly overlapping agreement structure is a stable objection to the JGA by a coalition of one or more players; and (b) when all agreement structures are feasible, there is no stable objection to the JGA.*

In our three-country example, the conditions of Proposition 4.2 are:
(a) $\pi_j^{7*} > \pi_j^1$ and $\pi_k^7* = \pi_h^{7*} > \pi_k^2 = \pi_h^2$, where 7^* indicates structure 7 and its

mirror images;
(b.1) Within the set of partially overlapping agreement structures that two countries k and h could put forward as counterobjections to 7^* (including agreement structures 5 and 6 and their mirror images), consider the agreement structure, G', that yields the highest payoff for countries k and h. Then it must be true that (i) $\pi_k^{G'} = \pi_h^{G'} > \pi_k^{7*} = \pi_h^{7*}$; and (ii) $\pi_j^{G'} < \pi_j^1$; and
(b.2) No partially overlapping agreement structures (including agreement structures 3, 4, 5, 6, 8, 9 and 10 and their mirror images) is a stable objection to the JGA.

Which of the above scenarios will apply (if any) depends on several factors. If we take the trade policy side in isolation (i.e. set $\delta = 0$), with three symmetric countries, two countries always gain when forming a trade bloc with coordinated tariff setting (a CU) in comparison with a no-coordination scenario (see, for example, Kennan and Riezman, 1990); furthermore the excluded country always gain from a move to free trade from a two-country bloc situation. In such a setting, the gains from forming a two-country bloc to the participating countries, and the cost of such move to the excluded country, increase with the importance of trade as reflected in the magnitude of μ.

On the environmental policy side, leaving trade aside (i.e. setting $\mu = 0$), the incentives for one country to leave the global environmental agreement and free ride on a partial coordination agreement between the other two, other things equal, increase with the size of the damage and decreases with the elasticity of environmental policy responses to changes in marginal damage valuation, which in turn depends primarily on θ (the lower θ the easier it is to free ride), but also on the parameters directly affecting tradeables demand. The value of the inverse elasticity of marginal damage valuation (corresponding to the elasticity of abatement demand with respect to marginal damage) also determines whether two countries have an incentive to engage in partial cooperation over environmental policy if the other country does not participate: as environmental policy responses become more inelastic, free-riding by the non-participating country can become so severe as to make noncooperation preferable for the remaining two. This is a well-known result and a theme that runs through the literature on environmental

agreement formation.[20]

Note, however, that in this model emissions abatement can only take place through a reduction in the production of tradeables; this means that emission taxes coincide with output taxes, which are a relatively close substitute for export taxes (and, equivalently, import tariffs), and that in turn import tariffs are a substitute for emission taxes with respect to environmental policy goals. Consequently, the effects of trade and environmental policy instruments on payoffs are not additive, and thus trade policy and environmental policy incentives cannot be separated in as clearcut a manner as the above discussion suggests. In particular, as μ approaches unity, import tariffs and emission taxes become progressively more equivalent.

To illustrate the potential effects of a negotiation tie-in restriction, below we present four different examples, involving alternative parameterizations of the model. We focus on a scenario with a symmetric bargaining-based distribution rule within agreements. In the present model, even if countries are ex-ante identical, asymmetric payoff distributions could still arise between two participants to an agreement if they do not also participate in the same agreements outside the given one (as in agreement structures 8-10)—a complication that is absent in one-dimensional agreement formation games. We consider alternative bargaining rules: Utilitarian bargaining ($B(\pi_i - \pi_i^D, i \in I^g) = \sum_{i \in I^g}(\pi_i - \pi_i^D)$) and Nash bargaining ($B(\pi_i - \pi_i^D, i \in I^g) = \prod_{i \in I^g}(\pi_i - \pi_i^D)$) without side payments,[21] and the case with side payments under a symmetric, strictly concave B.[22] In all cases the disagreement point for bargaining is given by the payoffs under structure 2.

Tables 4.1 to 4.4 report non-cooperative equilibrium payoffs under utilitarian bargaining under each of the ten agreement structures described in the previous subsection, for different parameterizations.[23] In all cases we set $\beta = 2/3$, $\delta = 4/3$,

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[20] See, for example, Barrett (1994).

[21] Note that, with quasilinear preferences, lump-sum transfers and utility transfers are equivalent. Transferable utility, however, does not imply that transfers need be feasible. Side payments are hardly observed in the practice of international agreements, perhaps because it is difficult or, in view of future commitments, undesirable to arrive at a precise determination of willingness to pay.

[22] With side payments and a symmetric disagreement point, any symmetric, strictly concave B will always yield an egalitarian outcome, i.e. identical payoff for all players. With a utilitarian B and side payments, on the other hand, the payoff distribution is indeterminate.

[23] Since no closed-form solutions for payoffs as a function of policies are available, we have used

$\eta = -3/2$, and $\gamma = 2$, and vary only the values of μ and θ. Equilibrium policy levels (not reported) range from zero to 2 for import tariffs and from 0.4 to 2 for emission taxes.

Consider first the scenario in Table 4.1, in which a large share of tradeable goods is imported ($\mu = 63/100$) and the inverse marginal damage valuation elasticity is large ($\theta = 3/2$). It is easy to verify that the JGA is stable if a tie-in rule is imposed: no subset of players is better off at 2 or 7 than at 1. In contrast, without tie-in the JGA can be blocked by country 1 putting forward structure 9: this is a stable objection, since all the possible counterobjections by 2 and 3 (structures 2, 3, 5, 6, 7 and the mirror image of structure 8[24]) yield a lower payoff for them.

In this scenario, the imposition of a tie-in negotiation rule facilitates multilateral cooperation over trade and environmental policies (case (ii) of Section 4.3), by removing the possibility of profitable single-issue deviations—by a single country with respect to environmental policy, and by a partial alliance of two countries with respect to trade policy. With θ large, two countries prefer partial environmental policy cooperation between themselves to full noncooperation. This implies that, if a country attempts to free ride on environmental policy, the other two countries cannot credibly counter the move by resolving not to cooperate among themselves. At the same time, the gains from forming a trade bloc against a third country, for the two countries involved, and the cost of being excluded from a trade bloc, are sizeable (μ is large). This implies that, with a tie-in restriction, a single country would not find it profitable to exit from a multilateral cooperation agreement.

Consider next a scenario where all parameters are the same as in Table 4.1 but the inverse elasticity of marginal damage valuation is lower (Table 4.2). Although the incentive to move to structure 9 still exists for countries 1, this deviation would not be stable whether or not a tie-in restriction is present, because countries 2 and 3 would counterobject to it by moving to structure 3 where they obtain a higher payoff by not coordinating on environmental policy and where country 1 obtains a lower payoff in comparison with structure 1. Thus, in this scenario tie-in is irrelevant, because even without it the JGA would be stable (case (i) of Section

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numerical methods to obtain the non-cooperative payoff values.

[24]The relevant mirror image of structure 8 is one in which countries 1 and 2 cooperate over trade and countries 2 and 3 over environment, yielding $\pi_1 = 0.704$, $\pi_2 = 0.668$ and $\pi_3 = 0.656$.

Table 4.1: Agreement Structures and Countries' Payoffs
$\mu = 63/100$, $\theta = 3/2$, $\gamma = 2$, $\eta = -3/2$, $\beta = 2/3$, $\delta = 4/3$

Agreement Structure		Countries' Payoffs (π_1, π_2, π_3)
1:	$\{\{T_1, T_2, T_3\}, \{E_1, E_2, E_3\}\}$	(0.722, 0.722, 0.722)
2:	$\{\{T_1\}, \{T_2\}, \{T_3\}, \{E_1\}, \{E_2\}, \{E_3\}\}$	(0.656, 0.656, 0.656)
3:	$\{\{T_1, T_2, T_3\}, \{E_1\}, \{E_2\}, \{E_3\}\}$	(0.696, 0.696, 0.696)
4:	$\{\{T_1\}, \{T_2\}, \{T_3\}, \{E_1, E_2, E_3\}\}$	(0.700, 0.700, 0.700)
5:	$\{\{T_1\}, \{T_2\}, \{T_3\}, \{E_1\}, \{E_2, E_3\}\}$	(0.703, 0.667, 0.667)
6:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1\}, \{E_2\}, \{E_3\}\}$	(0.607, 0.692, 0.692)
7:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1\}, \{E_2, E_3\}\}$	(0.642, 0.695, 0.695)
8:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1, E_2\}, \{E_3\}\}$	(0.656, 0.668, 0.704)
9:	$\{\{T_1, T_2, T_3\}, \{E_1\}, \{E_2, E_3\}\}$	(0.742, 0.697, 0.697)
10:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1, E_2, E_3\}\}$	(0.656, 0.716, 0.716)

Table 4.2: Agreement Structures and Countries' Payoffs
$\mu = 63/100$, $\theta = 3/4$, $\gamma = 2$, $\eta = -3/2$, $\beta = 2/3$, $\delta = 4/3$

Agreement Structure		Countries' Payoffs (π_1, π_2, π_3)
1:	$\{\{T_1, T_2, T_3\}, \{E_1, E_2, E_3\}\}$	(0.824, 0.824, 0.824)
2:	$\{\{T_1\}, \{T_2\}, \{T_3\}, \{E_1\}, \{E_2\}, \{E_3\}\}$	(0.764, 0.764, 0.764)
3:	$\{\{T_1, T_2, T_3\}, \{E_1\}, \{E_2\}, \{E_3\}\}$	(0.812, 0.812, 0.812)
4:	$\{\{T_1\}, \{T_2\}, \{T_3\}, \{E_1, E_2, E_3\}\}$	(0.793, 0.793, 0.793)
5:	$\{\{T_1\}, \{T_2\}, \{T_3\}, \{E_1\}, \{E_2, E_3\}\}$	(0.794, 0.771, 0.771)
6:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1\}, \{E_2\}, \{E_3\}\}$	(0.717, 0.803, 0.803)
7:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1\}, \{E_2, E_3\}\}$	(0.735, 0.803, 0.803)
8:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1, E_2\}, \{E_3\}\}$	(0.764, 0.793, 0.793)
9:	$\{\{T_1, T_2, T_3\}, \{E_1\}, \{E_2, E_3\}\}$	(0.838, 0.810, 0.810)
10:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1, E_2, E_3\}\}$	(0.764, 0.805, 0.805)

4.3).

Let us now consider the scenario depicted in Table 4.3, in which both the import share parameter and the inverse elasticity of marginal damage valuation are small ($\mu = 1/10, \theta = 2/5$). Recall that under a tie-in restriction only agreement structures 1, 2 and 7 (and its mirror images) are feasible. Country 1 now benefits from moving from 1 to 7, because the costs of forgoing trade cooperation are low and more than offset by the gains from free-riding on environmental cooperation. Under a tie-in constraint, countries 2 and 3 are unable to counterobject, since their payoff under structure 2 is lower than under structure 7; hence structure 7 constitutes a stable objection to the JGA. If, on the other hand, there is no tie-in restriction, structure 6 is a stable counterobjection to 7 there is no tie-in restriction, structure 6 is a stable counterobjection to 7 (under 6 players 2 and 3 obtain a higher payoff than under 7, and player 1 obtains a lower payoff than under 1). Thus, without a tie-in restriction, structure 7 is not a stable objection by player 1 to the JGA. Removing a tie-in restriction introduces structure 9 as a possible objection, but this also is unstable.

In this scenario, a tie-in negotiation rule hinders multilateral cooperation over trade and environmental policies (case (iii) of Section 4.3), because it removes the ability for two countries to effectively counter single-country objections. With θ small, if a country chooses not to participate in a multilateral environmental agreement, the two remaining countries are better off if they cease environmental cooperation among themselves. This means that free-riding attempts by a single country could be credibly countered by a move to trade policy-only cooperation between the remaining two. With a tie-in restriction, however, the incentives for two countries to keep cooperating along the trade policy dimension override their incentives to split along the environmental policy dimension, making single-country objections stable and the JGA unstable.

In the case represented in Table 4.4, all the parameters are as in Table 4.3, except for the inverse marginal damage elasticity θ, which is now higher. Under a tie-in restriction, country 1 still benefits from moving from 1 to 7, which remains a stable deviation from the JGA. Now, however, even without a tie-in restriction, this objection cannot be countered by structure 6, since countries 2 and 3 no longer benefit from splitting a partial environmental agreement. This is because a higher

Table 4.3: Agreement Structures and Countries' Payoffs
$\mu = 1/10$, $\theta = 2/5$, $\gamma = 2$, $\eta = -3/2$, $\beta = 2/3$, $\delta = 4/3$

Agreement Structure		Countries' Payoffs (π_1, π_2, π_3)
1:	$\{\{T_1, T_2, T_3\}, \{E_1, E_2, E_3\}\}$	(0.907, 0.907, 0.907)
2:	$\{\{T_1\}, \{T_2\}, \{T_3\}, \{E_1\}, \{E_2\}, \{E_3\}\}$	(0.863, 0.863, 0.863)
3:	$\{\{T_1, T_2, T_3\}, \{E_1\}, \{E_2\}, \{E_3\}\}$	(0.870, 0.870, 0.870)
4:	$\{\{T_1\}, \{T_2\}, \{T_3\}, \{E_1, E_2, E_3\}\}$	(0.902, 0.902, 0.902)
5:	$\{\{T_1\}, \{T_2\}, \{T_3\}, \{E_1\}, \{E_2, E_3\}\}$	(0.928, 0.862, 0.862)
6:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1\}, \{E_2\}, \{E_3\}\}$	(0.859, 0.868, 0.868)
7:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1\}, \{E_2, E_3\}\}$	(0.923, 0.866, 0.866)
8:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1, E_2\}, \{E_3\}\}$	(0.862, 0.863, 0.933)
9:	$\{\{T_1, T_2, T_3\}, \{E_1\}, \{E_2, E_3\}\}$	(0.936, 0.867, 0.867)
10:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1, E_2, E_3\}\}$	(0.897, 0.905, 0.905)

Table 4.4: Agreement Structures and Countries' Payoffs
$\mu = 1/10$, $\theta = 4/5$, $\gamma = 2$, $\eta = -3/2$, $\beta = 2/3$, $\delta = 4/3$

Agreement Structure		Countries' Payoffs (π_1, π_2, π_3)
1:	$\{\{T_1, T_2, T_3\}, \{E_1, E_2, E_3\}\}$	(0.815, 0.815, 0.815)
2:	$\{\{T_1\}, \{T_2\}, \{T_3\}, \{E_1\}, \{E_2\}, \{E_3\}\}$	(0.749, 0.749, 0.749)
3:	$\{\{T_1, T_2, T_3\}, \{E_1\}, \{E_2\}, \{E_3\}\}$	(0.754, 0.754, 0.754)
4:	$\{\{T_1\}, \{T_2\}, \{T_3\}, \{E_1, E_2, E_3\}\}$	(0.811, 0.811, 0.811)
5:	$\{\{T_1\}, \{T_2\}, \{T_3\}, \{E_1\}, \{E_2, E_3\}\}$	(0.840, 0.756, 0.756)
6:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1\}, \{E_2\}, \{E_3\}\}$	(0.744, 0.753, 0.753)
7:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1\}, \{E_2, E_3\}\}$	(0.834, 0.759, 0.759)
8:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1, E_2\}, \{E_3\}\}$	(0.751, 0.759, 0.845)
9:	$\{\{T_1, T_2, T_3\}, \{E_1\}, \{E_2, E_3\}\}$	(0.847, 0.760, 0.760)
10:	$\{\{T_1\}, \{T_2, T_3\}, \{E_1, E_2, E_3\}\}$	(0.806, 0.814, 0.814)

θ implies positive net benefits from partial environmental cooperation compared with the non-cooperative outcome.[25] In this scenario tie-in is irrelevant, because even without it the JGA would be unstable (case (iv) of Section 4.3).

Table 4.5 shows payoffs for the asymmetric structures 8, 9 and 10, and their mirror images, under alternative bargaining rules—Utilitarian and Nash bargaining without side payments and symmetric bargaining with side payments—in each of the four parameterizations. Payoffs in structures 1-7 are unaffected. Results remain the same in some scenarios but change in others. Under Nash bargaining and bargaining with side payments, tie-in becomes irrelevant in the first parameterization (as in Table 4.1), since structure 9 is no longer attractive for player 1 in comparison to the JGA. Under the third parameter configuration (as in Table 4.3), a tie-in restriction makes the JGA unstable in both the Utilitarian case without side payments and the case with side payments; with Nash bargaining without any restrictions structure 7 is not a stable objection as in the other two cases, but structure 9 becomes a stable objection to the JGA. Changing bargaining rules makes no difference in the second and fourth parameterizations.

4.5 Concluding Remarks

In this chapter we have described an analytical framework for investigating policy coordination choices when players can enter into selective and separate agreements with different partners along different policy dimensions. We have then applied our model of multi-dimensional agreement formation to the study of trade and environmental negotiations between three symmetric countries, focusing on the effects of a tie-in negotiation rule for the stability of multilateral cooperation over trade and environmental policies.

Multilateral cooperation over environmental policy is hindered by an individual country's incentive to free ride on a partial environmental agreement formed by the other two, while trade cooperation is undermined by the incentive for two countries to form a trade bloc against a third country. It has been suggested that

[25] Note, however, that a higher θ also implies a smaller difference in the net benefits between partial environmental cooperation and no cooperation. This is in the line with the results of Barrett (1994), who shows that international environmental agreements can be self-enforcing only when they can marginally improve upon the non-cooperative outcome.

Table 4.5: Countries' Payoffs under Alternative Bargaining Rules
$\gamma = 2,\ \eta = -3/2,\ \beta = 2/3,\ \delta = 4/3$

Structure	Countries' Payoffs (π_1, π_2, π_3)		
	Utilitarian	Nash	Side Payments
$\mu = 63/100,\ \theta = 3/2$			
8	(0.656, 0.668, 0.704)	(0.656, 0.656, 0.656)	(0.685, 0.685, 0.685)
9	(0.742, 0.697, 0.697)	(0.716, 0.712, 0.712)	(0.712, 0.712, 0.712)
10	(0.656, 0.716, 0.716)	(0.677, 0.702, 0.702)	(0.697, 0.697, 0.697)
$\mu = 63/100,\ \theta = 3/4$			
8	(0.764, 0.793, 0.793)	(0.760, 0.766, 0.769)	(0.786, 0.786, 0.786)
9	(0.838, 0.810, 0.810)	(0.822, 0.819, 0.819)	(0.820, 0.820, 0.820)
10	(0.764, 0.805, 0.805)	(0.773, 0.798, 0.798)	(0.793, 0.793, 0.793)
$\mu = 1/10,\ \theta = 2/5$			
8	(0.862, 0.863, 0.933)	(0.864, 0.864, 0.918)	(0.886, 0.886, 0.886)
9	(0.936, 0.867, 0.867)	(0.917, 0.875, 0.875)	(0.890, 0.890, 0.890)
10	(0.897, 0.905, 0.905)	(0.901, 0.903, 0.903)	(0.902, 0.902, 0.902)
$\mu = 1/10,\ \theta = 4/5$			
8	(0.751, 0.759, 0.845)	(0.758, 0.759, 0.832)	(0.785, 0.785, 0.785)
9	(0.847, 0.760, 0.760)	(0.828, 0.768, 0.768)	(0.789, 0.789, 0.789)
10	(0.806, 0.814, 0.814)	(0.810, 0.812, 0.812)	(0.811, 0.811, 0.811)

one way to offset free-riding incentives and help sustain more cooperation would be to make trade cooperation conditional on environmental cooperation.[26] To do so, countries should commit to a tie-in restriction on international negotiations, which would rule out the possibility of signing single-issue agreements. Formally, such a restriction could be thought of as emerging in an initial constitutional stage in which countries can credibly commit to a certain negotiation process.

Our analysis shows that conditionality could indeed play a positive role, by eliminating stable objections to the JGA. But in some cases negotiation tie-in could actually become a hurdle to multilateral cooperation, by making an otherwise stable JGA unstable. If this is the more likely scenario, the policy implication would be that conditionality should be rejected in favour of a flexible system where countries remain free to decide whether to negotiate multiple-issue agreements or single-issue agreements containing clauses that make them compatible with other agreements (e.g. trade rules allowing countries to use trade remedies against countries that are in violation of a formally separate environmental agreement).

Our results also suggest that conditionality can only play a positive role with respect to "small" environmental problems (small in terms of the associated welfare costs and benefits in comparison with the costs and benefits of trade policies), but is more likely to be an impediment to cooperation for broader issues such as climate change. This provides a rationale for what seems to be the prevailing position in policy circles with respect to global climate treaties.[27]

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[26] This idea is implicit in the proposal for an International Agreement on Trade and Environment (International Institute for Sustainable Development, 1996).

[27] The need for a *separate* "World Environment Organization (...), an institutional and legal counterpart to the World Trade Organization", has been stressed by Renato Ruggiero, Director-General of the WTO, in his opening speech at the High Symposium on Trade and Environment, 15th March 1999.

Chapter 5

Trade Bloc Formation Under Imperfect Competition

5.1 Introduction

Despite the strengthening of the world trading system through the successful conclusion of the Uruguay Round, there is still some concern that the formation of preferential trade agreements may result in the fragmentation of the world economy.[1] The risk is that "countries that join trading blocs will be more protectionist towards countries outside the blocs than they were before, so that the world as a whole will be hurt more than helped by moves that at first seem to be liberalizing in intent." (Krugman, 1991, p. 9).

This concern is supported by studies of trade bloc formation focused on perfectly competitive markets, which find that the creation of customs union (CUs), while beneficial to the member countries, can be harmful to non-member countries and may reduce the welfare of the world as a whole.[2]

[1] According to Fratzsher (1996), 94% of world trade is conducted within or between the European Union (EU), the North American Free Trade Agreement (NAFTA) and the Association for South East Asian Nations (ASEAN). In the period 1948-1994, GATT contracting parties notified 118 preferential trade agreements relating to trade in goods, of which 38 in the five years ending in 1994. Since the completion of the Uruguay Round, 80 additional PTAs covering trade in goods and services have been notified. See Whalley and Hamilton (1996) and Sampson (1996) for more information about the recent increase in the number of preferential trade agreements.

[2] For example, Kennan and Riezman (1990) and Kose and Riezman (1999) construct a pure exchange general equilibrium model with three countries and three goods, in which trade pat-

In this chapter, we want to examine the process of trade bloc formation in the context of imperfectly competitive markets. For this purpose, we employ a simple three-country model of intra-industry trade, in which governments can alter the strategic interaction between oligopolistic firms through the use of import tariffs and export subsidies. The subsidization of firms engaged in international rivalry is common practice in most industrialized countries,[3] but cannot be explained by traditional trade theories: while import tariffs can improve a country's terms of trade, export subsidies do not appear to make much sense, since they improve the terms of trade of the importing country. The literature on strategic trade policy,[4] on the other hand, has shown that imperfect competition can create new motives for the use of import tariffs and export subsidies: when domestic and foreign firms compete in the domestic market, Brander and Spencer (1984a,b) have shown that a tariff can be used to shift rents from foreign firms to the domestic firms and treasury; when domestic and foreign firms compete in a third country, Brander and Spencer (1985) have demonstrated that export subsidies can increase welfare by shifting profits from foreign to domestic firms.[5]

We describe international trade relations as a three-stage process. In the first stage, countries decide whether or not to form cooperative trade agreements. These can take three forms: 'pure' customs unions (CUs), in which member countries eliminate tariffs among themselves and set a common external tariff to maximize

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terns are determined by comparative advantage considerations. Using simulation techniques to compare optimal tariffs and welfare gains in alternative agreement structures, they show that for certain endowment distributions CUs can pose a threat to the multilateral trading system, since, due to the improvement in their terms of trade, member countries can obtain larger welfare gains than at the free trade equilibrium.

[3]Since direct payments by the government to exporters are prohibited by GATT/WTO rules, countries often use indirect forms of support. Examples of covert export subsidies are: currency retention schemes which involve a bonus on exports; provision of goods or services for use in the production of exported goods on terms more favourable than those for the production of goods for domestic consumption; export-related exemption, remission or deferral of direct taxes and social welfare charges; excess exemption, remission, or deferral of indirect taxes or import duties; and export credits extended at rates below the government's cost of funds. See Ray (1995) for a discussion.

[4]See Brander (1995) for an extensive review of this literature.

[5]The profit-capture motive of trade intervention is most clearly seen when domestic and foreign firms are competing in a third country, since the home consumer surplus is not at issue.

their joint welfare[6]; agreements to coordinate the use of export subsidies only; and 'impure' CUs, involving the coordinated use of both policy instruments.[7] In the second stage, tariffs and subsidies are selected—cooperatively among countries participating in an agreement and non-cooperatively between countries belonging to separate agreements. In the last stage, firms compete in quantities.

There is a presumption that, when they are combined, export subsidies and import tariffs will 'neutralize' each other. This presumption is misleading in our setup, since the optimal response to a foreign export subsidy is never a fully countervailing tariff. A similar result is obtained, in a two-country context, by Dixit (1984, 1988) and Collie (1991).[8]

We analyze the welfare implications of alternative trade arrangements. Then, using the concept of Stable Agreement Structure developed in the previous chapter, we examine the sustainability of the Joint Global Agreement—entailing international cooperation on both policy variables. We find that, if the traded goods are homogeneous, *'impure' CUs are stumbling blocs against the attainment of multilateral trade cooperation.* If instead products are nationally differentiated, trade bloc formation might or might not pose a threat to multilateral cooperation, depending on the degree of industry concentration and the extent of product differentiation.

We show that the introduction of an international ban on export subsidies could make multilateral trade cooperation sustainable when it would not be otherwise. Therefore our analysis provides a rationale for recent strengthening of GATT/WTO rules against export subsidies (see Laird, 1999).[9]

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[6] An example of a pure CU is provided by the Southern Common Market (MERCOSUR).

[7] The European Union can be considered an example of an 'impure' CU: its state aid policy restricts the capacity of national governments to support their firms and delegates to the Commission the task of ensuring that all subsidies granted within the EU are compatible with the single market objectives (see Cini and McGowan, 1998).

[8] Dixit (1984, 1988) and Collie (1991) describe the following three-stage game: in the first stage, the foreign country sets its export subsidy; in the second stage, the domestic country chooses optimal tariffs; finally, domestic and foreign firms engage in Cournot competition. Both studies find that the optimal retaliation against a foreign export subsidy is a partially countervailing tariff.

[9] An alternative rationale is suggested by Bagwell and Staiger (1994). In their model, export subsidies are used to coordinate the entry decision of firms. They show that, when subsdidy coordination does more to prevent entry than to promote entry, the world as a whole can be better off when export subsidies are banned.

There has been little attempt to look at trade bloc formation in models of strategic trade policy. Sinclair and Vines (1994) have extended Brander and Spencer (1984a)'s tariff model to consider the impact of the creation of CUs and free trade areas (FTAs) on the Nash equilibrium tariffs. However, they have not considered the welfare implications of trade bloc formation. In an infinitely repeated version of Brander and Spencer (1985)'s export subsidy game, Collie (1993) has shown that free trade can be sustained by the threat of retaliation with the Nash equilibrium export subsidies, provided that countries are similar and the discount factor is sufficiently high. A multi-country version of this model is employed by Collie (1997) to study the effects of trade bloc enlargement. Differently from our analysis, all these studies look at the effects of exogenous trade bloc formation, without considering countries' agreement choices.

Our analysis is close in spirit to Yi (1996), who employs a multi-country extension of Brander and Spencer (1984a)'s tariff model to describe endogenous trade bloc formation under imperfect competition. He addresses the issue of the sustainability of global free trade under alternative rules of CU formation.[10] The main difference with our analysis is that Yi (1996) assumes that import tariffs are the only available instrument, so that 'pure' CUs are the only potential threat to the global trading system. This allows him to reach a more optimistic conclusion about the sustainability of multilateral trade cooperation in the case of three ex-ante symmetric countries.

A general result emerging from our analysis is that *modelling trade negotiations as being on tariffs only can be misleading*, i.e. might result in drawing incorrect conclusions about the negotiation outcomes.

Various studies have examined how international tariff negotiations might be affected by the existence of alternative policy instruments. For example, Coopeland (1990) has analyzed the general case of bilateral tariff negotiations when there exist non-negotiable domestic policy instruments. Gatsios and Karp (1992) have looked at the imperfect harmonization of trade and industrial policies and note the

[10] Yi (1996) finds that CUs are stepping stones towards global free trade if membership of a trade agreement is open to all players, but they might be stumbling blocs towards free trade if the formation of a trade bloc requires the agreement of all potential members and the number of negotiating countries exceeds a critical value. In the case of three countries, he finds that global free trade is always sustainable.

possibility of welfare reducing preferential trade agreements when members coordinate only the use of tariffs. A similar result is obtained by Richardson (1999), who shows that the uncoordinated use of domestic taxes/subsidies can render a 'pure' CU unattractive. More recently, Richardson (1999), focusing on the interaction between trade and competition policies, finds that the formation of a CU improves members' welfare only if it goes beyond mere trade coordination. However, none of these studies examines the endogenous formation of trade blocs and the issue of the sustainability of multilateral trade cooperation.

The chapter is structured as follows. In Section 5.2, we present a simple three-country model of intra-industry trade. In Section 5.3, we look at the welfare implications of alternative trade arrangements. In Section 5.4, we examine the stability of such arrangements. Section 5.5 considers the effects of the introduction of an international ban on export subsidies. Finally, section 5.6 contains some concluding remarks.

5.2 The Model

In this section, we describe a simple model of intra-industry trade between three ex-ante symmetric countries. The specification of production draws on the reciprocal-markets trade model first proposed by Brander (1981) and elaborated by Brander and Krugman (1983) and Dixit (1984).

Each country $i \in I \equiv \{1, 2, 3\}$ is endowed with an amount $\bar{M}_i$ of a numeraire good, which is transferred across countries to settle the balance of trade.

A crucial assumption of the reciprocal-markets model is that *markets are segmented*, in the sense that firms make separate strategic decisions concerning different markets, rather than selling their output in a unified or integrated world market and relying on arbitrage to distribute it to different locations.[11] This assumption is appropriate for sectors of the economy in which firms have the ability to price discriminate between countries, thus maintaining a dominant position in their domestic markets.[12]

[11] Alternatively, one could assume that oligopolistic firms compete in an integrated market (see, for example, Horstmann and Markusen, 1986) or make a two stage decision, setting first their world-wide capacity, and then market specific quantities or prices (Venables, 1990).

[12] For example, there is some evidence of markets segmentation in the European car market (see

On the production side, we assume that n identical firms are located in each market.[13] All firms in a particular country produce an identical good at constant marginal cost c, but products are nationally differentiated. Let q_{ik} be sales in country k (destination) by a firm located in country i (origin), and $Q_k = \sum q_{ik}$ be total sales in country k.

Preferences of a representative consumer in country k can be described by the following quasilinear utility function

$$u_k(M_k, Y_k, \theta) \equiv M_k + v_k \equiv M_k + aY_k - b\left(\frac{\theta}{2}Y_k^2 + \frac{1-\theta}{2}\sum_i y_{ik}^2\right), \quad k \in I, \tag{5.1}$$

where M_k is the consumption of the numeraire good[14], y_{ik} is consumption by country k (destination) of a good produced in country i (origin), and $Y_k = \sum_i y_{ik}$ is k's total consumption. The product differentiation parameter θ ranges from 0 (independent goods) to 1 (homogeneous goods). Country k's inverse demand for country i's good is given by

$$P_{ik} = a - b\left[(1-\theta)y_{ik} + \theta Y_k\right]. \tag{5.2}$$

Market clearing requires that total consumption must be equal to total sales, i.e. $y_{ik} = nq_{ik}$ and $Y_k = n\sum_i y_{ik}$.

Governments can alter the strategic interaction between oligopolistic firms through the use of import tariffs and export subsidies. Let t_{ik} denote country k's tariffs on imports from country i and s_{ki} be its export subsidy (for home firms' exports to country i).

The sequential structure of the model consists of three stages. In the first stage, countries decide whether to select policies unilaterally or form cooperative

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Flam and Nordstrom, 1994) and in the market for computer chips (see Baldwin and Krugman, 1988).

[13]We assume that the number of firms in each country is fixed. This can be regarded as a short-run situation or as a situation in which there are legal or technical entry barriers. See Brander and Krugman (1983) and Markusen and Venables (1988) for an analysis of the implications of trade liberalization with free entry.

[14]We assume that $\bar{M}_i$ is large enough to guarantee a positive consumption of the numeraire good.

trade agreements.[15] Countries may choose to coordinate the use of tariffs only. In this case, we assume that they form 'pure' customs unions (CU), eliminating tariffs among themselves[16] and selecting a common external tariff so as to maximize their joint welfare.[17] Alternatively, countries may decide to form agreements to cooperatively select export subsidies. A third option is to form 'impure' CUs, involving the coordinated use of both tariffs and subsidies. We rule out international transfers.[18]

In the second stage, tariffs and subsidies are selected— cooperatively among countries participating in an agreement and non-cooperatively between countries belonging to separate agreements. In the final stage, firms compete by choosing quantities in each market. As usual, we start by analyzing the last stage of the game, and solve for the equilibrium for the full game by backward induction.

In the absence of transport costs,[19] the effective cost of supplying the traded good to country k for the firm located in country i is $c + t_{ik} - s_{ik}$ and its profits are given by

$$\pi_{ik} = (P_{ik} + s_{ik} - c - t_{ik})q_{ik}, \tag{5.3}$$

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[15] We assume that countries can credibly commit to trade cooperation and that international trade agreements are binding. Our analysis thus differs from the strand of the literature which argues against the legitimacy of assuming binding commitments in international trade negotiations (e.g. Bagwell and Staiger, 1997).

[16] One might also consider the more general case in which the CUs are characterized by non-zero tariffs between members. One institutional justification for the internal zero-tariff assumption is the fact that the General Agreement on Tariffs and Trade (GATT) permits the formation of preferential trade agreements provided that "the duties and other restrictive regulations of commerce are eliminated on substantially all trade between the constituents territories in products originating in such territories" (Article XXIV).

[17] As underlined by Gatsios and Karp (1995) and Park (2000), trade negotiations will generally involve a conflict between countries of different sizes. However, by focusing on symmetric countries, we remove the possibility of the emergence of this conflict.

[18] While it may be that transfers are important, to analyze them one has to first know what happens in their absence. The role of side-payments in international trade negotiations is analyzed by Kowalczyk (1994).

[19] Differently from Brander (1981) and Brander and Krugman (1983), we assume that firms do not incur any transport costs in supplying foreign markets. However, such costs are assumed to be prohibitive for any third-party arbitragers.

with associated first-order condition[20]

$$\frac{\partial \pi_{ik}}{\partial q_{ik}} = a - c - b(1+n)q_{ik} - bn\theta \sum_{j \neq i} q_{jk} + s_{ik} - t_{ik} = 0. \tag{5.4}$$

Equation (5.4) represents the reaction functions (in implicit form) for the firms supplying market k. It shows the best-reply output of a firm, given whatever level of output is produced by the other firms. Notice that the profit function satisfies Hahn (1962)'s condition for stability of a Cournot equilibrium:

$$\frac{d\pi_{ik}}{dq_{jk}} < 0, \quad \forall i \neq j,$$

that is, each firm's marginal revenue in one market declines as the output of any other firm rises.[21] Solving (5.4) for all $k \in I$, we obtain domestic and foreign sales in country k at the Cournot equilibrium:

$$q_{kk}(\vec{t_{ik}}, \vec{s_{ik}}) = \frac{\alpha(1+n-\theta n) + \theta n(\sum_{i \neq k} t_{ik} - \sum_{i \neq k} s_{ik})}{\delta}, \tag{5.5}$$

$$q_{ik}(\vec{t_{ik}}, \vec{s_{ik}}) = \frac{\alpha(1+n-\theta n) + (1+n+\theta n)\,(s_{ik} - t_{ik}) + \theta n t_{jk}}{\delta}, \tag{5.6}$$

where $\alpha = a - c$ is a measure of market size and is assumed to be positive (since otherwise a firm will never produce any output), $\delta = b(1+n-\theta n)(1+n+2\theta n) > 0$, and $\vec{t_{ik}}$ and $\vec{s_{ik}}$ are the vectors of tariffs and subsidies for all firms selling in country k.

Notice that the quantities produced for market k do not depend on variables in markets other than k. As noted by Brander (1981), this separability property depends crucially on the assumption of constant marginal costs.[22]

Negative solutions to equations (5.5)-(5.6) are possible but not meaningful, so the reaction functions are truncated at zero. We rule out corner solutions, assuming that in equilibrium each firm produces a strictly positive outcome. Since

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[20] With linear demand, since profits functions are concave, the second-order conditions for profit-maximization are satisfied and there exist a unique Cournot-Nash equilibrium.

[21] Expression (5.2) also implies that the strategic variables q_{ik} and q_{jk} are strategic substitutes as defined by Bulow *et al.* (1985).

[22] If marginal costs depended on production levels, market separability would be lost and one could not rule out the kind of strategies considered by Krugman (1984), where an advantage given to a firm in one market spills over into a further advantage in another market.

all firms sell both at home and abroad, market equilibrium involves intra-industry trade, even when firms located in different countries sell homogeneous products (cross-hauling).

Equations (5.5)-(5.6) imply the following comparative statics effects:

$$\frac{dq_{ik}}{ds_{ik}} = \frac{1+n-\theta n}{\delta} > 0, \tag{5.7}$$

$$\frac{dq_{kk}}{ds_{ik}} = \frac{dq_{jk}}{ds_{ik}} = -\frac{\theta n}{\delta} < 0, \tag{5.8}$$

$$\frac{dq_{ik}}{dt_{ik}} = -\frac{1+n+\theta n}{\delta} < 0, \tag{5.9}$$

$$\frac{dq_{kk}}{dt_{ik}} = \frac{dq_{jk}}{dt_{ik}} = \frac{\theta n}{\delta} > 0, \tag{5.10}$$

From (5.7) and (5.8) it follows that, when a country increases its subsidy for exports to a given market, its sales in that market increase, while the sales of all other countries fall. Equations (5.9) and (5.10) imply that, when a country increases its tariff on imports from a given country, imports from that county fall, while imports from other countries and its own domestic sales increase.

Given the quasilinearity of the utility function, if profits and tax revenues are rebated back uniformly to all consumers, country k's welfare can be written as the sum of domestic consumer surplus (CS), government revenues (GR), and total profits of domestic firms in all markets (Π). Using (5.4), we can express a firm's domestic and foreign profits as $\pi_{kk} = bq_{kk}^2(\vec{t_{ik}}, \vec{s_{ik}})$ and $\pi_{ki} = bq_{ki}^2(\vec{t_{ki}}, \vec{s_{ki}})$, respectively. Welfare can thus be written as

$$\begin{aligned} W_k(\vec{t_{ik}}, \vec{s_{ik}}, \vec{t_{ki}}, \vec{s_{ki}}) \quad & \equiv CS_k + GR_k + \Pi_k \\ & \equiv v_k(\vec{t_{ik}}, \vec{s_{ik}}) - \sum_k nq_{ik}(\vec{t_{ik}}, \vec{s_{ik}})p_{ik}(\vec{t_{ik}}, \vec{s_{ik}}) + \\ & n\left(\sum_{i\neq k} t_{ik}q_{ik}(\vec{t_{ik}}, \vec{s_{ik}}) - \sum_k s_{ki}q_{ki}(\vec{t_{ki}}, \vec{s_{ki}})\right) + \\ & n\left(bq_{kk}^2(\vec{t_{ik}}, \vec{s_{ik}}) + \sum_{i\neq k} bq_{ki}^2(\vec{t_{ki}}, \vec{s_{ki}})\right). \end{aligned} \tag{5.11}$$

In the model described above, there are two sorts of gains from trade: the *pro-competitive gains* generated by the reduced market power of the domestic industry, and the *increase in the variety of goods* available to consumers. It is important to notice that, due to the quasilinearity of the utility function and to the assumption of market segmentation, there are *no terms of trade effects*.[23]

5.3 Agreement Structures and Welfare

In this section, we examine the welfare implications of alternative trade arrangements. Since the countries are symmetric, we can limit our analysis to the following nine agreement structures:[24]

1. Joint Global Agreement (JGA):
   $\{\{t_1, t_2, t_3\}, \{s_1, s_2, s_3\}\}$;

2. No agreement on either issue (Nash Equilibrium):
   $\{\{t_1\}, \{t_2\}, \{t_3\}, \{s_1\}, \{s_2\}, \{s_3\}\}$;

3. Global tariff agreement, no agreement on subsidies:
   $\{\{t_1, t_2, t_3\}, \{s_1\}, \{s_2\}, \{s_3\}\}$;

4. Global agreement on subsidies, no tariff agreement:
   $\{\{t_1\}, \{t_2\}, \{t_3\}, \{s_1, s_2, s_3\}\}$;

5. Partial agreement on subsidies, no tariff agreement:
   $\{\{t_1\}, \{t_2\}, \{t_3\}, \{s_1, s_2\}, \{s_3\}\}$;

6. Partial tariff agreement, no agreement on subsidies ('pure' CU):
   $\{\{t_1, t_2\}, \{t_3\}, \{s_1\}, \{s_2\}, \{s_3\}\}$;

7. Partial overlapping agreements on tariffs and subsidies ('impure' CU):
   $\{\{t_1, t_2\}, \{t_3\}, \{s_1, s_2\}, \{s_3\}\}$;

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[23] As remarked by Yi (1996), terms of trade effects are placed solely on the numeraire good.

[24] Notice that we exclude the scenario in which one country coordinates the use of import tariffs with one partner and the use of export subsidies with another, i.e. agreement structure $\{\{t_1, t_2\}, \{t_3\}, \{s_1\}, \{s_2, s_3\}\}$ and its mirror images.

8. Global tariff agreement and partial agreement on subsidies: $\{\{t_1, t_2, t_3\}, \{s_1, s_2\}, \{s_3\}\}$;

9. Global agreement on subsidies and partial tariff agreement: $\{\{t_1, t_2\}, \{t_3\}, \{s_1, s_2, s_3\}\}$.

For simplicity, and without loss of generality, in the rest of our analysis we set $\alpha = b = 1$. We first consider the case in which the traded goods are homogeneous ($\theta = 1$), and then examine the case in which firms produce nationally differentiated goods ($\theta < 1$).

5.3.1 The Case of Homogeneous Goods

The optimal policies and equilibrium welfare functions for the case of homogeneous goods can be found in Appendix C. Table 5.1 reports the welfare gains obtained in different agreement structures, under alternative assumptions about the number of firms located in each market.

As expected, welfare gains increase with the number of firms located in each market. This is due to pro-competitive effects associated with the decrease in industry concentration. Notice that, as n increases, the difference between the welfare gains obtained in different structures falls. The intuition behind this result is that, as markets become more competitive, the profit-shifting incentives for the use of import tariffs and export subsidies tend to disappear.[25]

The analysis of Table 5.1 also reveals that agreement structures 1, 4 and 9 and agreement structures 5 and 7 yield the same welfare gains. This implies that tariff coordination is irrelevant for countries that are already coordinating the use of export subsidies.

Comparing the welfare gains obtained under alternative agreement structures, we obtain the following result:

Lemma 5.1 *In the case of homogeneous goods, the welfare ranking is always as follows:* $W_{1,2}^{8} > W_{1,2}^{5,7} > W_{k}^{1,4,9} > W_{k}^{3} > W_{1,2}^{6} > W_{k}^{2} > W_{3}^{6} > W_{3}^{5,7} > W_{3}^{8}$.

[25] This can also be seen from Figures 5.3 and 5.4 in Appendix C. The analytical results presented in Appendix C show that, as $n \to \infty$, optimal tariffs and subsidies in all agreement structures tend to zero.

Table 5.1: Agreement Structures and Countries' Welfare (Homogeneous Goods) ($\theta = 1$)

Agreement Structure	Countries' Welfare		
	$n = 1$	$n = 5$	$n = 8$
1) $\{\{t_1, t_2, t_3\}, \{s_1, s_2, s_3\}\}$	$W_k = 0.5$	$W_k = 0.5$	$W_k = 0.5$
2) $\{\{t_1\}, \{t_2\}, \{t_3\}, \{s_1\}, \{s_2\}, \{s_3\}\}$	$W_k = 0.4339$	$W_k = 0.4902$	$W_k = 0.4952$
3) $\{\{t_1, t_2, t_3\}, \{s_1\}, \{s_2\}, \{s_3\}\}$	$W_k = 0.4922$	$W_k = 0.4994$	$W_k = 0.4997$
4) $\{\{t_1\}, \{t_2\}, \{t_3\}, \{s_1, s_2, s_3\}\}$	$W_k = 0.5$	$W_k = 0.5$	$W_k = 0.5$
5) $\{\{t_1\}, \{t_2\}, \{t_3\}, \{s_1, s_2\}, \{s_3\}\}$	$W_{1,2} = 0.51$ $W_3 = 0.4$	$W_{1,2} = 0.5007$ $W_3 = 0.4871$	$W_{1,2} = 0.5003$ $W_3 = 0.4941$
6) $\{\{t_1, t_2\}, \{t_3\}, \{s_1\}, \{s_2\}, \{s_3\}\}$	$W_{1,2} = 0.4873$ $W_3 = 0.4229$	$W_{1,2} = 0.4989$ $W_3 = 0.4891$	$W_{1,2} = 0.4995$ $W_3 = 0.4948$
7) $\{\{t_1, t_2\}, \{t_3\}, \{s_1, s_2\}, \{s_3\}\}$	$W_{1,2} = 0.51$ $W_3 = 0.4$	$W_{1,2} = 0.5007$ $W_3 = 0.4871$	$W_{1,2} = 0.5003$ $W_3 = 0.4941$
8) $\{\{t_1, t_2, t_3\}, \{s_1, s_2\}, \{s_3\}\}$	$W_{1,2} = 0.5625$ $W_3 = 0.3437$	$W_{1,2} = 0.5208$ $W_3 = 0.4549$	$W_{1,2} = 0.5139$ $W_3 = 0.4707$
9) $\{\{t_1, t_2\}, \{t_3\}, \{s_1, s_2, s_3\}\}$	$W_k = 0.5$	$W_k = 0.5$	$W_k = 0.5$

PROOF: See Appendix C.

Therefore, relative to the Nash Equilibrium, all *preferential trade agreements will always increase the welfare of the member countries and decrease the welfare of the non-member country.*

Compared to the Joint Global Agreement, two countries will always loose by coordinating tariffs only (structure 6) and gain by coordinating the use of export subsidies (structures 5 and 7 and 8). The reason behind this result is that, by forming a preferential trade agreement on subsidies, two countries are able to shift rents from the firms located in the non-member country to their domestic firms and treasury.[26]

5.3.2 The Case of Heterogeneous Goods

We now turn our attention to the case of differentiated goods. Tables 5.2 and 5.3 report the welfare gains obtained in the nine agreement structures, under different assumptions about the degree of product differentiation and the number of firms located in each country.[27]

From Tables 5.2 and 5.3, we can see that welfare gains increase with the degree of product differentiation (i.e. decrease with θ). The reason behind this result is that, since individuals enjoy variety, an increase in product differentiation implies an increase in consumer surplus.

By comparing the welfare gains obtained in the nine agreement structures, we obtain the following result:

Lemma 5.2 *In the case of heterogeneous goods, the welfare ranking of alternative agreement structures depends on the degree of product differentiation and on the number of firms located in each market.*

PROOF: from Tables 5.2 and 5.3, we can see that countries' preferences over alternative trade arrangements vary with n and θ. For example, in Table 5.2

[26] This can be seen by comparing the equilibrium policies reported in Appendix C. It is easy to verify that, relative to the JGA, in structures 5, 7 and 8, countries 1 and 2 always choose to subsidize less their exports to country 3 and to subsidize more their exports to each other's markets.

[27] The analytical expressions for the equilibrium policies and welfare functions used to derive the results in Tables 5.2 and 5.3 can be obtained upon request.

Table 5.2: Agreement Structures and Countries' Welfare (Heterogeneous Goods) $(n = 1)$

Agreement Structure	Countries' Welfare		
	$\theta = 2/10$	$\theta = 1/2$	$\theta = 8/10$
1) $\{\{t_1, t_2, t_3\}, \{s_1, s_2, s_3\}\}$	$W_k = 1.0088$	$W_k = 0.7222$	$W_k = 0.5655$
2) $\{\{t_1\}, \{t_2\}, \{t_3\}, \{s_1\}, \{s_2\}, \{s_3\}\}$	$W_k = 0.7551$	$W_k = 0.5907$	$W_k = 0.4856$
3) $\{\{t_1, t_2, t_3\}, \{s_1\}, \{s_2\}, \{s_3\}\}$	$W_k = 0.8907$	$W_k = 0.6817$	$W_k = 0.5526$
4) $\{\{t_1\}, \{t_2\}, \{t_3\}, \{s_1, s_2, s_3\}\}$	$W_k = 1.0088$	$W_k = 0.7222$	$W_k = 0.5655$
5) $\{\{t_1\}, \{t_2\}, \{t_3\}, \{s_1, s_2\}, \{s_3\}\}$	$W_{1,2} = 0.9101$ $W_3 = 0.0.6957$	$W_{1,2} = 0.6903$ $W_3 = 0.5203$	$W_{1,2} = 0.5574$ $W_3 = 0.4329$
6) $\{\{t_1, t_2\}, \{t_3\}, \{s_1\}, \{s_2\}, \{s_3\}\}$	$W_{1,2} = 0.8306$ $W_3 = 0.7334$	$W_{1,2} = 0.6491$ $W_3 = 0.5650$	$W_{1,2} = 0.5356$ $W_3 = 0.4672$
7) $\{\{t_1, t_2\}, \{t_3\}, \{s_1, s_2\}, \{s_3\}\}$	$W_{1,2} = 0.9101$ $W_3 = 0.6957$	$W_{1,2} = 0.6903$ $W_3 = 0.5203$	$W_{1,2} = 0.5574$ $W_3 = 0.4329$
8) $\{\{t_1, t_2, t_3\}, \{s_1, s_2\}, \{s_3\}\}$	$W_{1,2} = 0.9788$ $W_3 = 0.7987$	$W_{1,2} = 0.7426$ $W_3 = 0.5500$	$W_{1,2} = 0.6068$ $W_3 = 0.4072$
9) $\{\{t_1, t_2\}, \{t_3\}, \{s_1, s_2, s_3\}\}$	$W_k = 1.088$	$W_k = 0.7222$	$W_k = 0.5655$

Table 5.3: Agreement Structures and Countries' Welfare (Heterogeneous Goods) $(n = 8)$

Agreement Structure	Countries' Welfare		
	$\theta = 2/10$	$\theta = 1/2$	$\theta = 8/10$
1) $\{\{t_1, t_2, t_3\}, \{s_1, s_2, s_3\}\}$	$W_k = 1.0683$	$W_k = 0.7485$	$W_k = 0.5760$
2) $\{\{t_1\}, \{t_2\}, \{t_3\}, \{s_1\}, \{s_2\}, \{s_3\}\}$	$W_k = 0.9320$	$W_k = 0.6973$	$W_k = 0.5585$
3) $\{\{t_1, t_2, t_3\}, \{s_1\}, \{s_2\}, \{s_3\}\}$	$W_k = 0.9547$	$W_k = 0.7140$	$W_k = 0.5705$
4) $\{\{t_1\}, \{t_2\}, \{t_3\}, \{s_1, s_2, s_3\}\}$	$W_k = 1.0683$	$W_k = 0.7485$	$W_k = 0.5760$
5) $\{\{t_1\}, \{t_2\}, \{t_3\}, \{s_1, s_2\}, \{s_3\}\}$	$W_{1,2} = 1.0242$ $W_3 = 0.8606$	$W_{1,2} = 0.7440$ $W_3 = 0.6320$	$W_{1,2} = 0.5766$ $W_3 = 0.5291$
6) $\{\{t_1, t_2\}, \{t_3\}, \{s_1\}, \{s_2\}, \{s_3\}\}$	$W_{1,2} = 0.9531$ $W_3 = 0.8926$	$W_{1,2} = 0.7148$ $W_3 = 0.6639$	$W_{1,2} = 0.5694$ $W_3 = 0.5449$
7) $\{\{t_1, t_2\}, \{t_3\}, \{s_1, s_2\}, \{s_3\}\}$	$W_{1,2} = 1.0242$ $W_3 = 0.8606$	$W_{1,2} = 0.7440$ $W_3 = 0.6320$	$W_{1,2} = 0.5766$ $W_3 = 0.5291$
8) $\{\{t_1, t_2, t_3\}, \{s_1, s_2\}, \{s_3\}\}$	$W_{1,2} = 1.0356$ $W_3 = 0.8793$	$W_{1,2} = 0.7542$ $W_3 = 0.6401$	$W_{1,2} = 0.5867$ $W_3 = 0.5278$
9) $\{\{t_1, t_2\}, \{t_3\}, \{s_1, s_2, s_3\}\}$	$W_k = 1.0683$	$W_k = 0.7485$	$W_k = 0.5760$

countries 1 and 2 obtain higher welfare gains in structure 8 than in structure 1, if $\theta = 1/2$ and $\theta = 8/10$ but not if $\theta = 2/10$.[28] This implies that multilateral cooperation is more attractive when the traded goods are more dissimilar. Also notice that in Table 5.2 countries 1 and 2 never gain by moving from structure 1 to structure 7; in Table 5.3, however, this move is profitable for the case in which $\theta = 8/10$. Therefore multilateral cooperation is more attractive when the industry is more concentrated. Q.E.D.

5.4 The Outcome of the Trade Negotiations

Having examined the welfare implications of alternative trade arrangements, we can now turn to the analysis of the first stage of the game, i.e. countries' agreement choices. As a solution, we use the concept of Stable Agreement Structure developed in the previous chapter. Here we just recall the two key definitions:

Definition 5.1 *A* Stable Agreement Structure *is a structure which cannot be blocked.*

Definition 5.2 *A coalition of one or more players constitutes a* blocking objection *to a proposed agreement structure if and only if: (i) it is profitable, i.e. at least one member of the blocking coalition gains from the deviation and no member loses; and (ii) it is immune from further deviations.*

As noted in the previous chapter, the stability definition is recursive: to be stable, a structure must not be blocked; and to block, an objection must involve an arrangement that is itself stable. This consistency requirement rules out coalitional deviations which are not themselves immune from further deviations.

Applying Definitions 1 and 2 to the case of homogeneous goods, we obtain the following result:

Proposition 5.1 *In the case of homogeneous goods, 'impure' CUs are the only stable negotiation outcome.*

[28] It is easy to verify that, when $n = 1$, $W_k^{1,4,9} > W_{1,2}^8$ if and only if $\theta < 0.1305$.

PROOF: from Lemma 5.1, we know that agreement structure 7 is welfare improving for countries 1 and 2, relative to all other agreement structures, except structure 8. However, the latter is not stable, since country 3 will always object to it by leaving the tariff agreement. Structure 7, on the other hand, cannot be blocked by country 3. It follows that the 'impure' CU structure is the only stable negotiation outcome.[29]

Therefore *'impure' CUs are stumbling blocs against the attainment of multilateral trade cooperation.* Since world welfare is always lower in the case of an 'impure' CU than in the JGA, Proposition 5.1 supports the concern that *the world as a whole will be hurt more than helped by the formation of regional trading blocs.*

Moving to the cases of heterogeneous products, we find:

Proposition 5.2 *When the goods are nationally differentiated, international trade negotiations will result in the formation of the JGA or of an 'impure' CU, depending on the degree of industry concentration and on the extent of product differentiation.*

PROOF: from Table 5.2, we can see that the welfare gains achieved in structure 1 (and in the equivalent structures 4 and 9) are larger than the gains obtained in any other agreement structure. This suggests that, when goods are differentiated and the industry is extremely concentrated (only 3 national firms are competing in each market), the JGA will be the only stable outcome. In this case, the members of an 'impure' CU gain more (in terms of product variety and increased domestic competition) by including the third country than they gain (in terms of profit-shifting) by excluding it. Table 5.3 shows that, if the industry is more competitive (24 firms are competing in each market) and traded goods are characterized by a low degree of product differentiation (e.g. $\theta = 8/10$), countries 1 and 2 can gain by putting forward structure 7, which country 3 will not be able to block. Therefore, if the product variety and pro-competitive effects of trade luberalization are small, 'impure' CUs represent a threat to multilateral trade cooperation. Q.E.D.

Notice that the rather pessimistic results obtained in our analysis are in contrast with the more optimistic conclusions of Yi (1996) who, assuming that import tariffs

[29] Structure 5—which is equivalent to structure 7—is also a stable outcome.

are the only available policy instrument, finds that free trade is the only stable outcome of the tariff negotiations between three ex-ante symmetric countries.[30]

5.5 An International Ban on Export Subsidies

Export subsidies are prohibited by GATT rules.[31] However, governments are often able to use indirect forms of export support. These include: more favourable credit conditions (the difference between these and the normal conditions applied to producers for the home market is paid by the government); insurance of certain risks (for example, that the foreign imported defaults) paid by the government; and promotional activities (such as trade fairs, advertising, etc.) organized by public agencies. For this reason, the WTO has recently attempted to strengthen the rules against the use of export subsidies (see Laird, 1999).[32]

In this section, we examine how the introduction of an effective ban on export subsidies would affect the outcome of the trade negotiations between three ex-ante symmetric countries. When import tariffs are the only available policy instrument, there are only five possible agreement structures, which, given the symmetry assumption, can be restricted to the following three:

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[30] Yi (1996) employs a multi-country extension of Brander ans Spencer (1984a)'s tariff game and focuses on the case in which only one firm is located in each country ($n = 1$). He computes the critical number of countries such that free trade is a stable outcome under both the open regionalism and unanimous regionalism rules. This is an increasing function of the degree of product differentiation. For example, for $\theta = 0.1$, free trade is a stable outcome if there are less than 15 countries, while for $\theta = 1$, the critical value is 4.

[31] In the original GATT agreement in 1947 there was very little discipline on subsidies. The first substantial obligations regarding the use of export subsides were introduced in 1955 (see Article XVI, paragraphs 2-5). A Subsidies Code was adopted at the Tokyo Round and revised at the Uruguay Round by the "Agreement on Subsidies and Countervailing Measures". The latter distinguishes between prohibited, actionable and nonactionable subsidies. See Jackson (1998) for a discussion of the evolution of the rules on subsidies and countervailing duties.

[32] A panel adopted by the WTO Dispute Settlement Body (DSB) in February 2000, requires, for the first time, a company to repay in full an illegal member subsidy from a member government. This case involves a dispute brought against Australia by the US over A$30 million in export subsidies to a producer of automotive leather. Two other recent cases involve export subsidies worth billions of $US: one rules against US tax exemptions for exporters; the other rules that Brazil has failed to lift the export subsidies to its jet aircraft industries, as required in a previous panel.

1. Global Free Trade:
   $\{\{t_1, t_2, t_3\}\}$;

2. Nash Equilibrium:
   $\{\{t_1\}, \{t_2\}, \{t_3\}\}$;

3. Partial tariff agreement ('pure' CU):
   $\{\{t_1, t_2\}, \{t_3\}\}$.

Tables 5.4-5.6 report the welfare gains obtained in the tariff-only agreement formation game, for the same parameter combinations considered in Tables 5.1-5.3.[33]

Comparing the welfare gains obtained in the three alternative agreement structures, we find:

Lemma 5.3 *When governments are banned from using export subsidies, the welfare ranking is always as follows:* $W_k^1 > W_{1,2}^3 > W_k^2 > W_3^3$.

PROOF: This result emerges from the analysis of Tables 5.4-5.6. Numerical simulations show that Lemma 5.3 holds for any degree of product differentiation and industry concentration, i.e. $\forall \;\; 0 \leq \theta \leq 1$, $n \geq 1$. The reason behind this result is that the gains associated with multilateral trade liberalization (i.e. the increase in domestic competition, product variety and export profits) always outweigh the corresponding welfare costs (i.e. the fall in domestic profits and government revenues). Q.E.D.

The result in Lemma 5.3 can also be seen from Figures 5.1 and 5.2, where we plot the welfare functions corresponding to the three agreement structures for the case of homogeneous goods ($\theta = 1$) and the case in which each country has only one firm ($n = 1$).

This result follows directly from Lemma 5.3:

Proposition 5.3 *When governments are banned from using export subsidies, global free trade is the only stable negotiation outcome.*

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[33] The analytical expressions for optimal policies and equilibrium welfare functions for the tariff-only game can be obtained upon request.

Table 5.4: Agreement Structures and Countries' Welfare (Homogeneous Goods) ($\theta = 1$)

Agreement Structure		Countries' Welfare		
		$n = 1$	$n = 5$	$n = 8$
1)	$\{\{t_1, t_2, t_3\}\}$	$W_k = 0.4688$	$W_k = 0.4981$	$W_k = 0.4992$
2)	$\{\{t_1\}, \{t_2\}, \{t_3\}\}$	$W_k = 0.42$	$W_k = 0.4893$	$W_k = 0.4949$
3)	$\{\{t_1, t_2\}, \{t_3\}\}$	$W_{1,2} = 0.4574$ $W_3 = 0.4055$	$W_{1,2} = 0.4967$ $W_3 = 0.4880$	$W_{1,2} = 0.4986$ $W_3 = 0.4944$

Table 5.5: Agreement Structures and Countries' Welfare (Heterogeneous Goods) ($n = 1$)

Agreement Structure		Countries' Welfare		
		$\theta = 2/10$	$\theta = 1/2$	$\theta = 8/10$
1)	$\{\{t_1, t_2, t_3\}\}$	$W_k = 0.8854$	$W_k = 0.6667$	$W_k = 0.5324$
2)	$\{\{t_1\}, \{t_2\}, \{t_3\}\}$	$W_k = 0.7517$	$W_k = 0.58$	$W_k = 0.4710$
3)	$\{\{t_1, t_2\}, \{t_3\}\}$	$W_{1,2} = 0.8262$ $W_3 = 0.7297$	$W_{1,2} = 0.6356$ $W_3 = 0.5523$	$W_{1,2} = 0.5151$ $W_3 = 0.4491$

Figure 5.1: Welfare Gains (Homogeneous Goods).

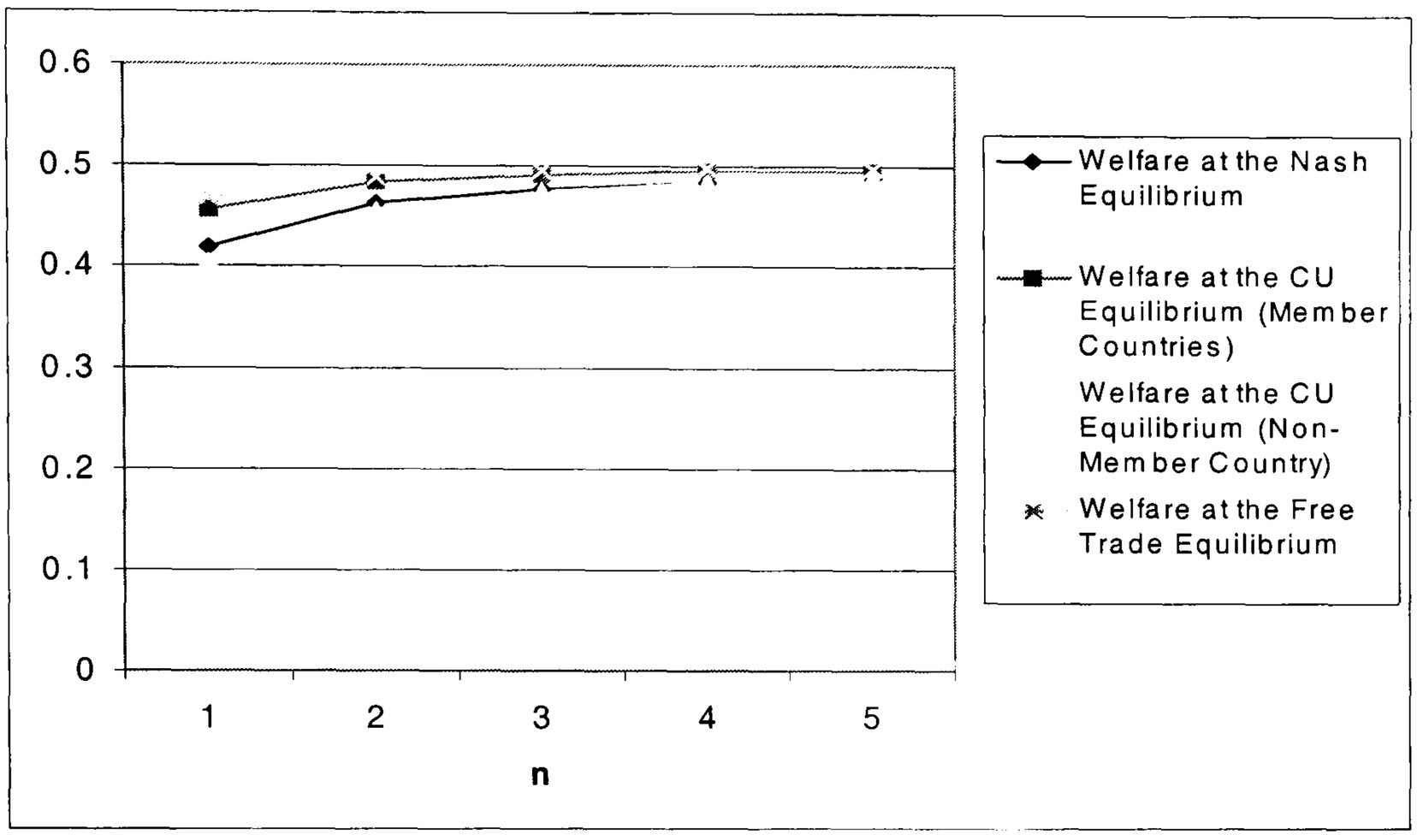


Figure 5.2: Welfare Gains (n =1).

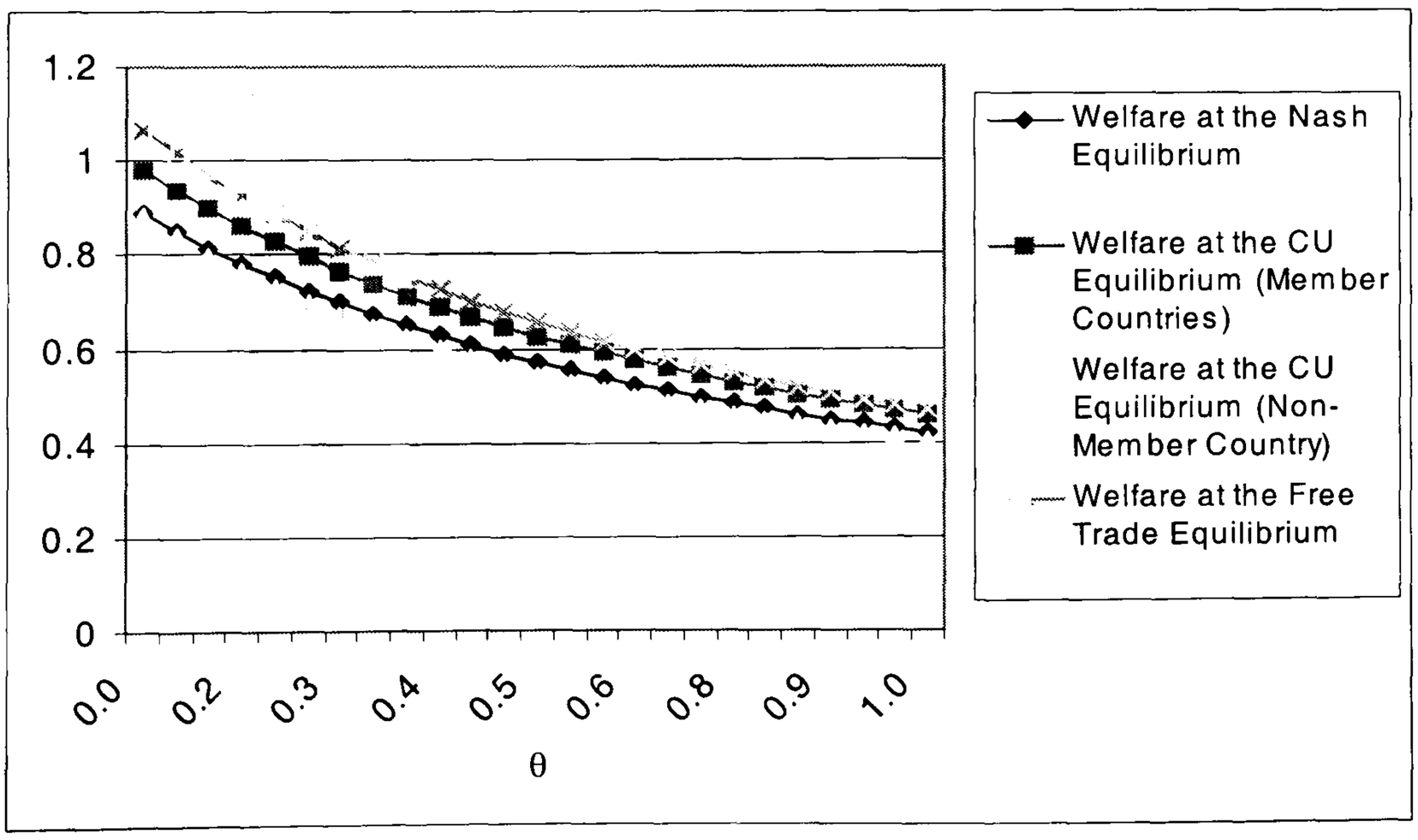


Table 5.6: Agreement Structures and Countries' Welfare (Heterogeneous Goods) $(n = 8)$

Agreement Structure	Countries' Welfare		
	$\theta = 2/10$	$\theta = 1/2$	$\theta = 8/10$
1) $\{\{t_1, t_2, t_3\}\}$	$W_k = 1.0642$	$W_k = 0.7474$	$W_k = 0.5757$
2) $\{\{t_1\}, \{t_2\}, \{t_3\}\}$	$W_k = 1.0492$	$W_k = 0.7384$	$W_k = 0.5677$
3) $\{\{t_1, t_2\}, \{t_3\}\}$	$W_{1,2} = 1.0581$ $W_3 = 1.0435$	$W_{1,2} = 0.7449$ $W_3 = 0.7315$	$W_{1,2} = 0.5743$ $W_3 = 0.5611$

PROOF: since global free trade (structure 1) yields larger welfare gains than any other tariff arrangements, no country will ever want to deviate from it. Q.E.D.

Combining Propositions 5.1-5.3, we can thus conclude that, in the case of three ex-ante symmetric countries, the introduction of an effective ban on subsidies would make multilateral trade cooperation sustainable when it would not be otherwise.

Proposition (5.3) is in line with the results obtained by Yi (1996) for the case of three ex-ante symmetric countries. Notice, however, that his optimistic conclusion about the sustainability of free trade would be misleading if countries were able to use export subsidies.

5.6 Concluding Remarks

In this chapter we have studied the formation of trade blocs when markets are imperfectly competitive and governments can alter the strategic interaction between oligopolistic firms through the use of import tariffs and export subsidies.

Using a simple model of intra-industry trade between three ex-ante symmetric countries, we have obtained the following results:

- Three factors determine whether preferential trade agreements pose a threat to the multilateral trading system: which policy instruments are at government disposal, the degree of industry concentration, and the extent of product differentiation;

- When both import tariffs and export tariffs are available, and the traded goods are homogeneous, 'impure' CUs—involving the coordinated use of both policy instruments—are always stumbling blocs towards multilateral trade cooperation;

- When both policy instruments are available and firms sell nationally differentiated products, multilateral cooperation is sustainable if the degrees of product differentiation and industry concentration are large enough;

- When countries are banned from using export subsidies, global free trade is the only stable negotiation outcome.

These findings provide a rationale for the recent attempts to strengthen international rules against the use of export subsidies.

A more general point emerges from our analysis: when governments can use different trade policy instruments, trade bloc formation should be described as a *multi-dimensional* agreement formation game; focusing on one policy dimension only might result in drawing incorrect conclusions about the negotiation outcomes.

We conclude by pointing out three directions of further research. First, it would be important to employ a multi-country version of our model to examine how the trade negotiation outcome are affected by changes in the number of parties involved. Second, it would be interesting to look at the case of heterogeneous countries; this would require the analysis of intra-agreement bargaining problems, in order to understand how agreement members divide total surplus. Finally, the strategic trade policy literature has shown that governments can use a wide range of instruments (import tariffs, export subsidies, domestic subsidies, voluntary export restraints, R&D subsidies, competition policy, etc.) to shift rents from foreign

to domestic firms. One could consider how the availability of different policy instruments can alter the process of trade bloc formation.

Appendix C

In what follows, we report the optimal policies and the corresponding welfare functions for the nine feasible agreement structures. We focus on two market structures: one in which n firms are located in each country, selling homogeneous products ($\theta = 1$); and one in which there are three firms, one in each market ($n = 1$), selling differentiated products ($\theta < 1$). We use subscripts to denote countries and superscripts to indicate the agreement structures.

Notice that, due to the quasilinearity of the utility function and to the assumption of market segmentation, a country's optimal policies are always independent on the policies of the rest of the world, i.e. *there is no strategic interdependence between countries.*

The Case of Homogeneous Products

1. $\{\{t_1, t_2, t_3\}, \{s_1, s_2, s_3\}\}$:

$$t_{ik}^1 = 0,$$

$$s_{ik}^1 = \frac{1}{2n},$$

$$W_k^1 = \frac{1}{2}. \tag{5.12}$$

2. $\{\{t_1\}, \{t_2\}, \{t_3\}, \{s_1\}, \{s_2\}, \{s_3\}\}$:

$$t_{ik}^2 = \frac{1+n}{1+7n+11n^2+3n^3},$$

$$s_{ik}^2 = \frac{1+3n+3n^2}{1+7n+11n^2+3n^3},$$

$$W_k^2 = \frac{n(6+49n+136n^2+154n^3+66n^4+9n^5)}{2(1+7n+11n^2+3n^3)}. \tag{5.13}$$

3. $\{\{t_1, t_2, t_3\}, \{s_1\}, \{s_2\}, \{s_3\}\}$:

$$t_{ik}^3 = 0,$$

$$s_{ik}^3 = \frac{1+n}{2(3+5n)^2},$$

$$W_k^3 = \frac{8+30n+25n^2}{2(3+5n)^2}. \tag{5.14}$$

4. $\{\{t_1\},\{t_2\},\{t_3\},\{s_1,s_2,s_3\}\}$:

$$t_{ik}^4 = \frac{1}{2n},$$

$$s_{ik}^4 = \frac{1}{n},$$

$$W_k^4 = \frac{1}{2}. \tag{5.15}$$

5. $\{\{t_1\},\{t_2\},\{t_3\},\{s_1,s_2\},\{s_3\}\}$:

$$t_{12}^5 = t_{21}^5 = \frac{1}{2},$$

$$t_{31}^5 = t_{32}^5 = s_{31}^5 = s_{31}^5 = 0,$$

$$t_{13}^5 = t_{23}^5 = \frac{1+2n+3n^2}{1+7n+9n^2+3n^2},$$

$$s_{12}^5 = s_{21}^5 = \frac{2}{n},$$

$$s_{13}^5 = s_{23}^5 = \frac{1-n}{1+7n+9n^2+3n^2},$$

$$W_{1,2}^5 = \frac{1+13n+58n^2+78n^3+45n^4+9n^5}{2(1+n)(1+6n+3n^2)^2}, \tag{5.16}$$

$$W_3^5 = \frac{n(6+31n+69n^2+45n^3+9n^4)}{2(1+n)(1+6n+3n^2)^2}. \tag{5.17}$$

6. $\{\{t_1\},\{t_2,t_3\},\{s_1\},\{s_2\},\{s_3\}\}$:

$$t_{12}^6 = t_{21}^6 = 0,$$

$$t_{31}^6 = t_{32}^6 = \frac{1+4n+6n^2}{2+14n+29n^2+18n^3},$$

$$t_{13}^6 = t_{23}^6 = \frac{1+3n+3n^2}{1+7n+11n^2+3n^3},$$

$$s_{12}^6 = s_{21}^6 = \frac{1+4n+3n^2}{2n+10n^2+9n^3},$$

$$s_{13}^6 = s_{23}^6 = \frac{1+n}{1+7n+11n^2+3n^3},$$

$$s_{31}^6 = s_{31}^6 = \frac{1+n}{2+14n+29n^2+18n^3},$$

$$\begin{aligned} W_{1,2}^6 = \quad & \frac{1}{\sigma}\Big\{3+82n+974n^2+6568n^3+27733n^4+76516n^5+139835n^6 \\ & +167990n^7+128832n^8+59418n^9+14661n^{10}+1458n^{11}\Big\}, \end{aligned} \tag{5.18}$$

$$\begin{aligned} W_3^6 = \quad & \frac{1}{\sigma}\Big\{n(24+472n+4024n^2+19476n^3+58930n^4+115793n^5 \\ & +148298n^6+120462n^7+58122n^8+14661n^9+1458n^{10}\Big\}, \end{aligned} \tag{5.19}$$

where $\sigma = 2(1+2n)(2+10n+9n^2)^2(1+7n+11n^2+3n^3)^2$.

7. $\{\{t_1,t_2\},\{t_3\},\{s_1,s_2\},\{s_3\}\}$:

$$t_{12}^7 = t_{21}^7 = \frac{1}{2},$$

$$t_{31}^7 = t_{32}^7 = s_{31}^5 = s_{31}^5 = 0,$$

$$t_{13}^7 = t_{23}^7 = \frac{1+2n+3n^2}{1+7n+9n^2+3n^2},$$

$$s_{12}^7 = s_{21}^7 = \frac{2}{n},$$

$$s_{13}^7 = s_{23}^7 = \frac{1-n}{1+7n+9n^2+3n^2},$$

$$W_{1,2}^7 = \frac{1+13n+58n^2+78n^3+45n^4+9n^5}{2(1+n)(1+6n+3n^2)^2}, \tag{5.20}$$

$$W_3^7 = \frac{n(6+31n+69n^2+45n^3+9n^4)}{2(1+n)(1+6n+3n^2)^2}. \tag{5.21}$$

8. $\{\{t_1,t_2,t_3\},\{s_1,s_2\},\{s_3\}\}$:

$$t_{12}^8 = t_{21}^8 = t_{31}^8 = t_{32}^8 = t_{13}^8 = t_{23}^8 = s_{31}^8 = s_{31}^8 = 0,$$

$$s_{12}^8 = s_{21}^8 = \frac{1}{n},$$

$$s_{13}^8 = s_{23}^8 = \frac{1-n}{4n(1+n)},$$

$$W_{1,2}^8 = \frac{5+4n}{8(1+n)}, \tag{5.22}$$

$$W_3^8 = \frac{1+6n+4n^2}{8(1+n)^2}. \tag{5.23}$$

9. $\{\{t_1,t_2\},\{t_3\},\{s_1,s_2,s_3\}\}$:

$$t_{12}^9 = t_{21}^9 = 0,$$

$$t_{31}^9 = t_{32}^9 = t_{13}^9 = t_{23}^9 = s_{12}^9 = s_{21}^9 = \frac{1}{2n},$$

$$s_{13}^9 = s_{23}^9 = s_{31}^9 = s_{31}^9 = \frac{1}{n},$$

$$W_k^9 = \frac{1}{2}. \tag{5.24}$$

Proof of Lemma 5.1

From the analysis of equations (5.12)-(5.24), it straightforward to verify that,

$\forall \;\; 0 \leq \theta \leq 1, n \geq 1,$

$W_{1,2}^{8} - W_{1,2}^{7,5} > 0,$

$W_{1,2}^{7,5} - W_{k}^{1,4,9} > 0,$

$W_{k}^{1,4,9} - W_{k}^{3} > 0,$

$W_{k}^{3} - W_{1,2}^{6} > 0,$

$W_{1,2}^{6} - W_{k}^{2} > 0,$

$W_{k}^{2} - W_{3}^{6} > 0,$

$W_{3}^{6} - W_{3}^{5} > 0,$

$W_{3}^{5} - W_{3}^{7} > 0.$

The welfare ranking of Lemma 5.1 emerges also from the analysis of Figures (5.3) and (5.4) in the next page, in which we plot the welfare gains obtained by the three countries under alternative agreement structures.

Q.E.D.

Figure 5.3: Welfare Gains for Countries 1 and 2

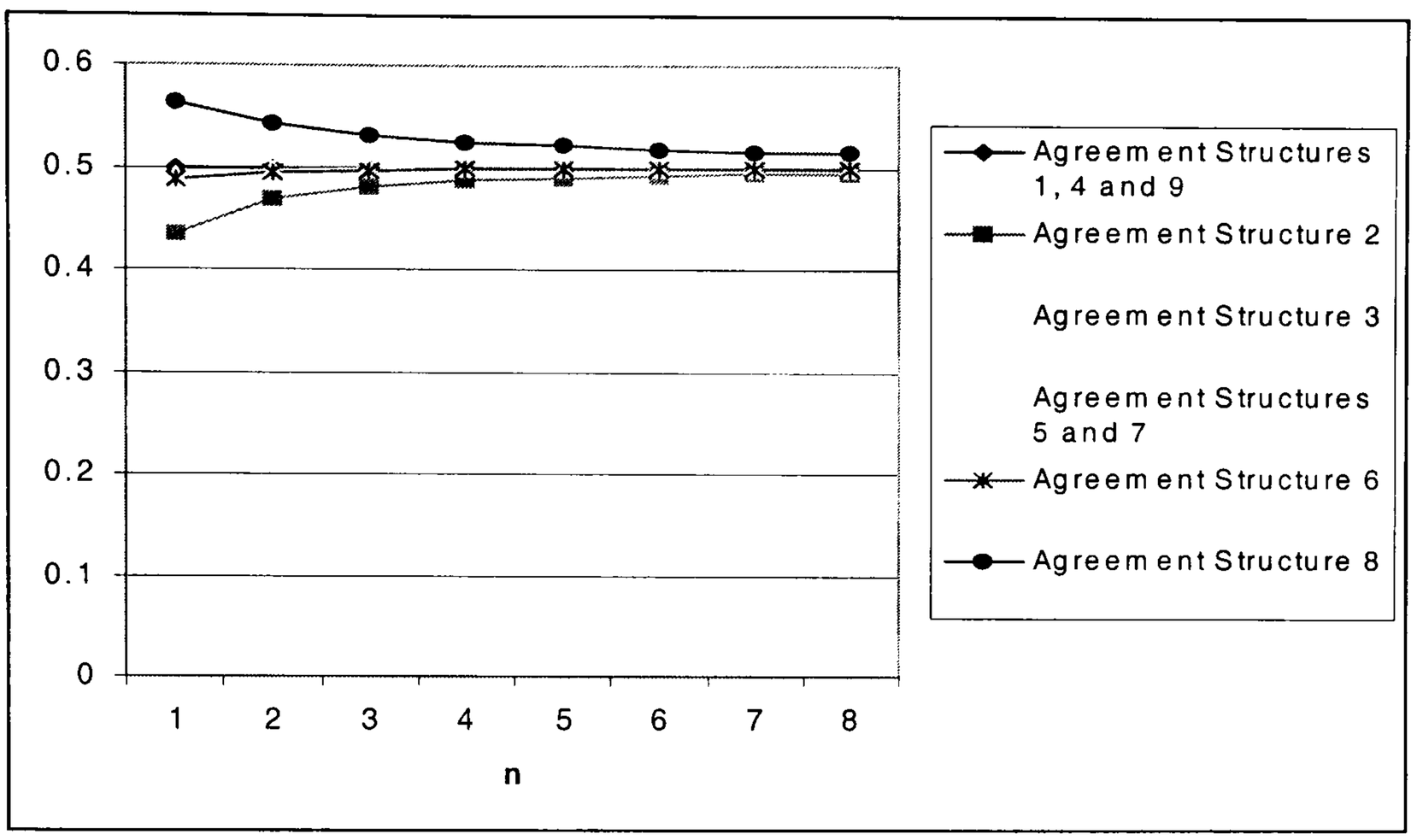
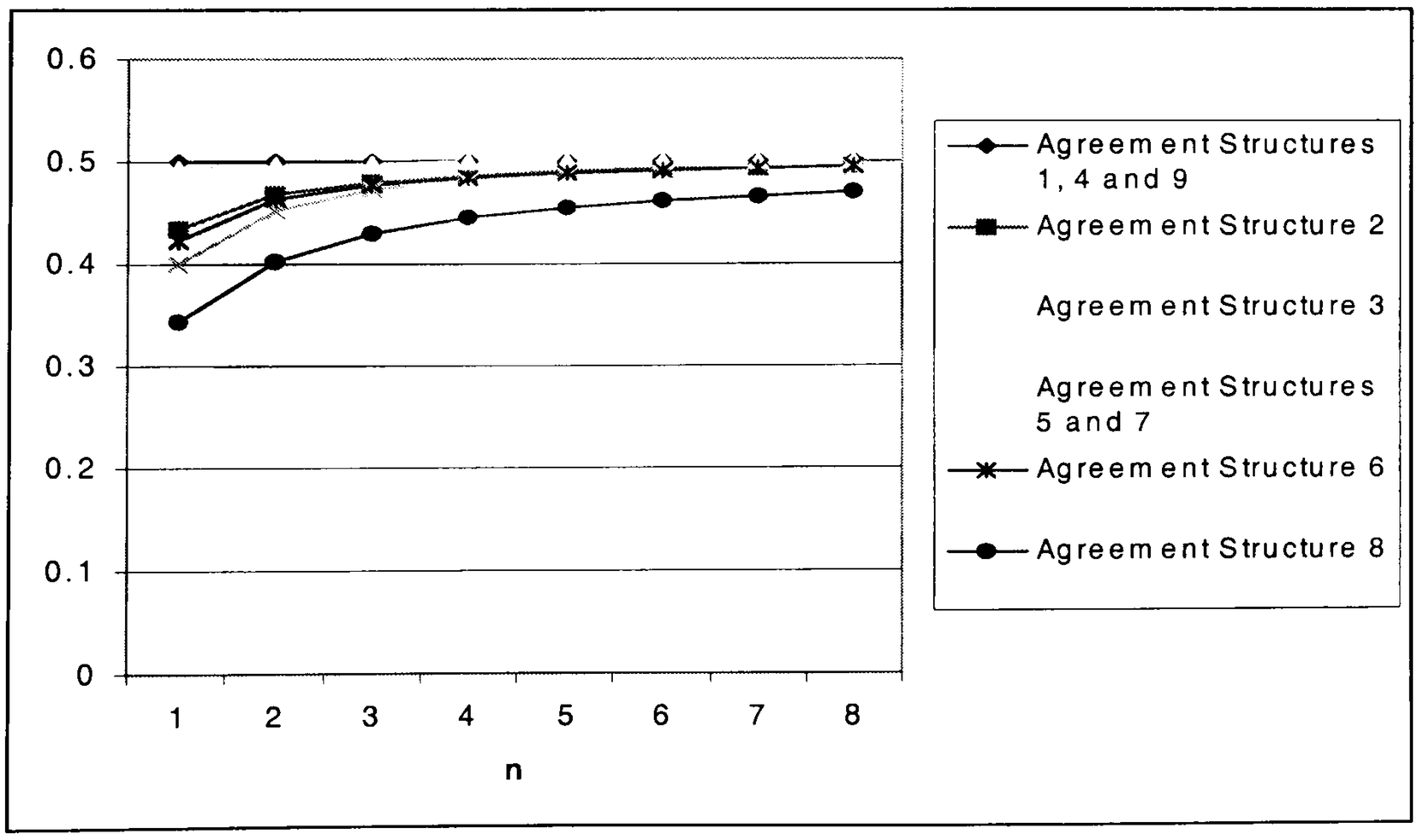


Figure 5.4: Welfare Gains for Country 3



Chapter 6

Conclusions

In this thesis we have examined different aspects of international relations on trade and environment. In the first part of the thesis, we have employed a common agency model of politics to examine how the existence of organized green and producer interest groups affects the political determination of trade and environmental policies. To our knowledge, ours is the only attempt to examine the role of interest groups on the *joint determination of trade and environmental policies.*

We have focused our political economy analysis on two large countries linked through trade and transboundary pollution. In this setup, unilateral efforts to reduce pollution by one country shift the comparative advantage of producing 'dirty' goods in favor of the other country. This implies an increase in foreign emissions, which the domestic residents dislike as well. The magnitude of these 'pollution leakages' depends on the extent of the emission spillovers and the terms of trade effects.

In Chapter 2, we have investigated the influence of green lobbies on the national and supra-national determination of trade and environmental policies. We have shown that the existence of 'pollution leakages' reduces the incentives of environmental groups to lobby for higher domestic pollution taxes. The main result of our analysis is that *the impact of green lobbies on the comparative efficiency of unilateral and cooperative environmental policies depends on the type of trade regime and on the magnitude of pollution leakages.* In the absence of pre-existing international trade agreements, the presence of green lobbies always biases pollution taxes upwards. In this case, if the size of the lobbies is large enough, uncoordinated

pollution taxes are closer to the efficient Pigouvian solution than internationally coordinated taxes. If, however, governments are bound by international trade rules, and the leakage effects are large enough, green lobbying could bias unilateral pollution taxes downwards. In this case, environmental policy coordination is unambiguously efficiency enhancing.

In Chapter 3, we have extended our analysis to examine the case in which both environmental and producer interests are politically organized. We have shown that the *nature of the relationship between the two lobby groups depends on three factors: the type of policy regime, whether the decision-making process is centralized or decentralized, and the magnitude of the pollution leakages.*

Our analysis predicts that, when trade and environmental policies are selected unilaterally and in isolation and the leakages effects are large enough, environmental and producer groups will be allied against a unilateral increase in domestic pollution taxes and in favor of protectionist trade policies.

In a regime in which both policy instruments are available, governments can eliminate 'pollution leakages' by combining the use of pollution taxes (to reduce domestic emissions) and import tariffs (to avoid increasing foreign emissions). In this case, green and producer groups will unambiguously be allied over trade policy and competing over environmental policy.

We show that the interests of green and producer lobbies will always be divergent in international environmental negotiations and they will be convergent in international trade negotiations if these are unaccompanied by efforts to reduce pollution.

In the second part of the thesis, we have examined the endogenous formation of trade and environmental agreements. In Chapter 4, we have developed a *model of multi-dimensional agreement formation*, where countries can enter into selective and separate binding agreements with different partners along different policy dimensions. We have described international relations as a two-stage game, in which agreements are formed in the first stage and policies are selected in the second stage—cooperatively among countries participating in an agreement and non-cooperatively between countries belonging to separate agreements. In this model, a stable agreement structure is reached if no subset of countries can credibly object to it.

We have then used this model to examine the implications of negotiation tie-in—the requirement that agreements must span multiple dimensions of interaction—for the viability of multilateral cooperation, when countries are linked by emission spillovers and international trade under perfect competition. Our analysis has shown that, *while in some cases a tie-in constraint has no effect or makes multilateral cooperation more viable, in others it makes a viable joint multilateral agreement unstable.*

In Chapter 5, we have employed the model of multi-dimensional agreement formation developed in the previous chapter to study the formation of international trade agreements, when markets are imperfectly competitive and governments use two policy instruments (import tariffs and export subsidies) to affect the interactions between oligopolistic firms. We have used a simple three-country model of intra-industry trade to examine whether preferential trade agreements are stepping stones or stumbling blocs towards the attainment of multilateral trade cooperation. We have described international trade relations as a three-stage process. In the first stage, countries decide whether or not to form cooperative trade agreements. In the second stage, tariffs and subsidies are selected—cooperatively among countries participating in an agreement and non-cooperatively between countries belonging to separate agreements. In the last stage, firms compete in quantities.

From the analysis of the welfare implications and the stability of alternative agreement structures, we have obtained the following results: (i) *three factors determine whether preferential trade agreements pose a threat to the multilateral trading system: which policy instruments are available, the degree of industry concentration, and the extent of product differentiation*; (ii) when both import tariffs and export tariffs are available, 'impure' CUs—involving the coordinated use of both policy instruments—can be stumbling blocs towards multilateral trade cooperation; (iii) if countries are banned from using export subsidies, the only stable negotiation outcome is global free trade. Thus our results provide a rationale for the recent attempts to strengthen international rules against the use of export subsidies.

Three broad themes emerge from the thesis. The first theme is that in representative democracies governments do not act as benevolent servants of the public interest. Instead, they shape their policies in response not only to the

concerns of the general electorate, but also to the pressure applied by special interest groups. Therefore, international relations involve *two distinct stages of strategic interaction*: in the first stage, political competition between the different interests determines the government's policy preferences; then the negotiations between national governments determine the international equilibrium.

The second theme is that international relations involve not only *the extremes of full cooperation and no cooperation, but also the possibility of partial cooperation.* Policies are selected cooperatively among members of an agreement and non-cooperatively between countries belonging to separate agreements.

The third theme emerging from our analysis is that international relations are characterized by *multiple dimensions of strategic interactions*, since they involve different policy issues (e.g. trade and environment) and policy instruments (e.g. import tariffs and export subsidies). Even when these dimensions are not directly interdependent—in the sense that the effects of choices along one dimension are dependent on choices along the others—there can still be cross-issue *negotiation* linkage: by exchanging concessions across different policy dimensions, two countries may be able to achieve cooperation in situations where there would otherwise be no scope for mutual gains to be attained.

Much of the literature on international policy cooperation has *separately examined cooperation over trade policies and over environmental policies.*[1] and has primarily been concerned with whether single-issue multilateral agreements are immune from the possibility of deviations by a subset of countries. The results obtained in Chapters 4 and 5 of this thesis point out that focusing on a single policy dimension might lead to drawing incorrect conclusions about the sustainability of multilateral cooperation.

The research carried out in this thesis suggests **three lines of future research**.

First, more work is needed to examine how economic policies—including trade and environmental policies—are determined by political and economic interests. In particular, to shed more light on the role played by interest groups in the domestic

[1] For example, Riezman (1985), Krugman (1991), Bond and Syropoulos (1993), and Yi (1996), among others, have focused on the creation of customs unions (CUs), while Carraro and Siniscalco (1993a, 1994), Barrett (1994b) and Chander ad Tulkens (1992), among others, have focused on International Environmental Agreements (IEAs).

and international political arenas, two crucial issues should be incorporated in our analysis: the *formation of lobby groups*, to explain why only some groups of citizens can overcome the free-rider problem of collective action described by Olson (1965) and get politically organized; and the *underlying electoral process*, to explain the objective function of the policy-makers.

Second, throughout our analysis we have assumed that the negotiating countries were ex-ante symmetric. This simplification has allowed us to abstract from the conflicts that would normally arise in the determination of cooperative policies. As hard as it may be, more attention should be devoted to the study of the *bargaining problems among heterogeneous agreements' members.* As shown in Chapter 4, alternative bargaining solutions would imply a different payoff division within agreements' members and might affect the negotiation outcome.

Finally, our model of multi-dimensional agreement formation could be applied to study the *linkages between trade liberalization and other policy issues*, such as competition policy or labor standards, which are included in the agenda for the new GATT/WTO negotiation round.

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